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Environmental Investigations Standard Operating Procedures and Quality Assurance Manual

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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SECTION 1
PREFACE

1.1 Introduction

This document, the Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, contains the standard operating and field quality assurance procedures used by Region 4 field investigators. The manual originated in 1980 with the title Engineering Support Branch Standard Operating Procedures and Quality Assurance Manual , was revised in 1986 with the same title. It was revised again in 1991 with the title, Environmental Compliance Branch Standard Operating Procedures and Quality Assurance Manual. In 1996, it was revised with the present title. The specific procedures outlined in the manual are based on the experiences of Region 4 field investigators or documents referenced at the end of each section.

This manual will be provided to each Region 4 employee responsible for conducting field investigations for activities contained in these Standard Operating Procedures (SOP). Each employee is expected to read and be familiar with each section of the SOP. This is intended to be a dynamic document and will be revised periodically as needed. Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

1.2 Performance Objectives

Performance objectives have been included at the beginning of sections and sub-sections where applicable. The performance objective lists the minimum requirements necessary for meeting the intent of the procedures that follow in the section. The purpose of the performance objective is to allow flexibility within field procedures where appropriate; however any deviations from the procedures in the SOP should be approved by the appropriate authority and thoroughly documented.

1.3 Section Objectives

Section objectives are included at the beginning of sections where performance objectives are not applicable. Section objectives provide a brief summary of the intention and content of the section.

SECTION 2
INVESTIGATIONS, INSPECTIONS, AND OVERVIEW ACTIVITIES

SECTION OBJECTIVES:

- Define the standard types of investigations, inspections, and field studies conducted.
- Outline the general requirements for study plans and reports for standard types of investigations, inspections and field studies.
- List available agency guidance and special requirements for the standard types of investigations, inspections, and field studies.

2.1 Introduction

The investigations, inspections, and overview activities conducted can be broadly categorized as either enforcement or non-enforcement related.

Enforcement related activities include criminal investigations, Resource Conservation and Recovery Act (RCRA) case development inspections, RCRA comprehensive ground water monitoring evaluations, water enforcement case preparation studies, National Pollutant Discharge Elimination System (NPDES) compliance monitoring, diagnostic evaluations of municipal wastewater treatment plants, investigations of Superfund hazardous waste sites, contractor overviews, investigations and monitoring of oil spills and Superfund spills, and investigations of toxic episodes and spills.

Non-enforcement activities include investigations of potential Superfund hazardous waste sites for National Priority Listing (NPL) purposes, technical assistance studies at municipal wastewater treatment plants, studies involving water quality and permitting issues, studies and inspections of abandoned hazardous waste sites, air quality studies, and a broad range of studies for national programs, as well as technical assistance studies for state and local agencies. However, studies and data derived from non-enforcement type investigations could be used for enforcement purposes. Field investigations include all environmental media (i.e., surface and ground water, air, soils, sediments) and wastes.

2.2 Potable Water Supply Investigations

Potable water supply investigations are usually conducted as part of a larger investigation such as a spill, leaking tanks, nearby superfund site, etc. However, an investigation may be conducted independently of a potential contamination source.

Potable water supply investigations may include collecting samples from wells, surface waters, distribution systems, private residential wells, etc.

Special procedures apply when a sample is collected from a private or public potable water supply. Investigators should always obtain the following information from the residents and/or owners in the event contaminants are detected in the sample:

- resident's and/or owner's name;
- resident's and/or owner's mailing address; and
- resident's and/or owner's home and work telephone numbers.

Immediately upon receipt of analytical data, the project leader should carefully examine the data. Web sites listed at the bottom of this section may be useful in an evaluation. If any of the primary or secondary drinking water standards are exceeded, or any priority pollutants, RCRA 40 CFR 261 Appendix VIII compounds, or the CERCLA 40 CFR 302 list of hazardous substances are detected, the project leader will immediately provide the information listed below to the appropriate individuals in the Water Management Division or Waste Management Division. The Water Management Division primary contact is Lee Thomas in the Water Programs Enforcement Branch; the secondary contact is Carol Tarras. The Waste Management Division primary contact is Glenn Adams in the Office of Technical Services; the secondary contact is Kevin Koporec.

- the analytical data;
- the name, address (including zip code) and telephone numbers of the residents and/or owners;
- the site name and location; and
- the EPA site identification number (if applicable).

Investigators should not release potable water supply data to anyone before providing it to the Water Management Division.

Web sites that may be useful:

For the current MCLs and SMCLS with potential health effects and sources:
http://www.epa.gov/OGWDW/wot/appa.html

For a summary of drinking water health advisories:
http://www.epa.gov/ost/drinking/standards/

Region 4 Office of Technical Services	http://www.epa.gov/region4/wastepgs/oftecser/oftecser.htm
Region 3 Risk Assessment tables	http://www.epa.gov/reg3hwmd/risk/riskmenu.htm
Region 9 Risk Assessment tables	http://www.epa.gov/region09/waste/sfund/prg/index.html
NCEA (ORD-Cinn.) web page	http://www.epa.gov/ncea/biblio.htm
Oak Ridge National Laboratory risk assessment page	http://risk.lsd.ornl.gov/homepage/rap_tool.htm
EPA's Intergrated Risk Information System (ref. doses and slope factors):	http://www.epa.gov/ngispgm3/iris/

2.3 Civil Enforcement Investigations and Studies

2.3.1 Introduction

This SOP covers the field and operational aspects of conducting field investigations; however, it is beyond the scope of this manual to cover all aspects of enforcement activities. Each enforcement investigation must be tailored to meet the needs of the anticipated enforcement action. The lead attorney and compliance specialists should be consulted on a continuing basis during the planning, conducting, and report writing phases of enforcement investigations.

Civil investigations are conducted for the Water and Waste Management Divisions and the Air, Pesticides, and Toxics Management Division to determine if a facility, site, or project is meeting the terms of a Consent Decree, order, water permit, etc. These investigations are conducted under a number of environmental laws which include:

- The Clean Water Act (CWA, PL 92-500)
- The Resource Conservation and Recovery Act (RCRA, PL 94-580)
- The Hazardous and Solid Waste Amendments (HSWA) of 1984
- The Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
- The Superfund Amendments and Re-authorization Act (SARA) of 1986
- The Clean Air Act (CAA 42 U. S.C. 1857 - 1857L, as amended)
- The Toxic Substances Control Act (TSCA, PL 94-469)

2.3.2 Facility Entry

Authority -- Various federal environmental statutes grant EPA enforcement personnel authority to enter and inspect facilities. The authority granted in each statute is similar to that stated below in Section 308 of the Clean Water Act:

- "(a)(B) the Administrator or his authorized representative, upon presentation of his credentials (i) shall have a right of entry to, upon, or through any premises in which an effluent source is located or in which any records required to be maintained. . .are located, and

- (ii) may at reasonable times have access to and copy any records, inspect any monitoring equipment or method required. . . , and sample any effluents which the owner or operator of such source is required to sample. . ."

For the specific requirements for conducting inspections and collecting data pursuant to a particular Act, see: Section 308 of the Clean Water Act; Section 9 of the Federal Insecticide, Fungicide, and Rodenticide Act; Section 3007 of the Resource Conservation and Recovery Act; Section 8 of the Toxic Substances Control Act; Section 1445 of the Safe Drinking Water Act; Section 104 of the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund); and Titles I, III, and IV of the Clean Air Act.

2.3.3 Unreasonable Search and Seizure

EPA authority under the various Acts is subject to the "unreasonable search and seizure" provisions of the Fourth Amendment to the Constitution. The prohibition is not against all searches and seizures, but only those which are unreasonable or which valid consent, if required, has not been given. Consent, in this context, means the intentional foregoing of right to privacy which is not the result of either fear, ignorance, or trickery.

To comply with the Acts and avoid any "unreasonable search" or procedural problems, a facility should be entered in the following manner:

1. The facility premises should be entered through the main gate or through the entrance designated by the source if in response to an inspection notification letter (a 308 letter for example).

2. The employee shall introduce herself/himself in a dignified, courteous manner to a responsible plant official. A responsible plant official may be the owner, operator, officer, or agent in charge of the facility, including the plant environmental engineer. <u>Identification credentials shall always be presented</u>.

3. If only a guard is present at the entrance, employees shall present their credentials and suggest that the guard call their superior on the telephone. If the field investigators know the name of the responsible official they are to see, they should request the guard call this individual directly.

4. If the company provides a general sign-in sheet, it is acceptable to sign it. Field investigators <u>shall not sign a release of liability (waiver) when entering a facility under the authority of Federal law</u>.

5. If entry is refused, field investigators shall not contest the issue with the facility representative, but will immediately do the following:

   - Obtain the name and position of the individual denying entry to the facility, and record the date and time.

   - Cite the appropriate EPA authority to conduct the inspection, ask if the individual denying entry heard and understood the reason for your presence and record the answer and any reasons given for denial of entry.

   - Leave the premises immediately.

After leaving the facility, the field investigators shall, at the earliest possible time, inform their immediate supervisor and the Office of Regional Counsel, by telephone of the events which took place and seek guidance on how to proceed.

2.3.4 Requesting Information

The various laws and statutes under which EPA operates address the protection of trade secrets and confidential information. As a general policy, field investigators should not accept confidential information unless it is necessary for carrying out Agency functions under a particular Act. As a matter of practice, requests for confidential information can only be signed by an Agency employee who has had the appropriate Confidential Business Information (CBI) training and certification.

In compliance with EPA regulations, an EPA request for company information, pursuant to statutory authority, will contain a statement allowing the facility to designate all or part of the information requested by the Agency as <u>confidential</u> by marking it according to: Code of Federal Regulations, Title 40, Part 2, Section 203.41; or Federal Register, 41 FR 36902. In addition to citing the appropriate regulations, the request for confidential information will state that:

1. The company may, if it desires, assert a business confidentiality claim covering part or all of the information in the manner described by [the applicable regulation], and that information covered by such a claim will be disclosed by EPA only to the extent, and by means of the procedures, set forth in [the applicable regulations]; and that

2. If no such claim accompanies the information when it is received by EPA, it may be made available to the public by EPA without further notice to the company.

If the collection of confidential information is required to carry out the responsibility of the Branch, personnel should consult carefully with the appropriate operating Division staff and the Office of Regional Counsel attorneys. In general, when such information is needed by Branch personnel, the request should state that this information will be transmitted directly to the Office of Regional Counsel.

In general, Branch personnel shall not accept confidential information when conducting a plant evaluation, inspection, or reconnaissance. When Branch personnel must collect or observe confidential information, a separate logbook shall be maintained. When confidential information is entered into an inspector's logbook, the entire logbook and each page containing confidential information shall be marked "CONFIDENTIALITY CLAIM." Upon returning to the EPA Region 4, facility, all such information shall be maintained in a locked filing cabinet and the Office of Regional Counsel shall be notified for ultimate disposition of the material.

All field investigators conducting investigations or inspections should be familiar with the inspection provisions of these acts, i.e., CWA (Section 308), RCRA (Section 3007), CERCLA (Section 104), and TSCA (Section 11).

2.3.5 Photographs

At no time should field investigators be denied the opportunity to take photographs during an investigation. If photographs are denied and no other means can be arranged to get the photographs, this is considered a denial of access by the facility. At some facilities the process operations and/or equipment may be claimed as being proprietary. In these cases, the facility may make a CBI request to the Office of Regional Council (ORC). Generally, providing the facility with a duplicate copy of uncut prints for their review is acceptable to both parties. If this is unacceptable to the facility, the investigator may allow the facility to take the photographs, review them, and provide copies to EPA.

2.3.6 Split Samples

The inspection provisions of RCRA (Section 3007) and CERCLA (Section 104) require that, "If the officer or employee obtains any samples, prior to leaving the premises, he shall give to the owner, operator, or agent in charge a receipt describing the samples obtained and if requested a portion of each such sample equal in volume or weight to the portion retained." As a matter of policy, an offer will be made to the owner, operator, or agent in charge to split all samples collected on facility property.

2.4 Criminal Investigations and Studies

At the request of the Criminal Investigations Division (CID) and with the concurrence of the Regional Administrator/Deputy Regional Administrator, technical support for criminal investigations is provided. Only experienced personnel with adequate training (such as on-site supervision by senior investigators or the Criminal Investigations Course offered by the Federal Law Enforcement Training Center) should be project leaders during such investigations. Technical support shall be provided at the request of the CID Special Agent-in-Charge of the investigation in accordance with Appendix F of this SOP.

2.5 Clean Water Act Compliance Monitoring Inspections

2.5.1 Introduction

The term "compliance monitoring" covers all activities undertaken to ascertain a permitee's or discharger's compliance status. This includes, but is not limited to, Clean Water Act (CWA) compliance monitoring inspections and compliance review, e.g., the review of Discharge Monitoring Reports (DMR) or compliance schedule reports. The main functions of CWA compliance monitoring inspections are to verify the integrity of the self-monitoring information and to develop the basis for possible follow-up compliance or enforcement actions. All compliance monitoring inspections shall be conducted as though an enforcement action would result. General guidance for conducting compliance monitoring inspections is found in the US EPA, NPDES Compliance Inspection Manual (1). Compliance monitoring inspections are usually requested by the Clean Water Act Enforcement Section, Water Programs Enforcement Branch, Water Management Division.

A number of different types of compliance monitoring inspections have been defined including: compliance evaluation inspections (CEI), compliance sampling inspections (CSI), toxic compliance sampling inspections (XSI), compliance biomonitoring inspections (CBI), performance audit inspections (PAI), diagnostic evaluations (DE), reconnaissance inspections (RI), pretreatment compliance inspections (PCI), sludge inspections (SI), legal support inspections (LSI), and Municipal Wastewater Treatment Plant technical assistance (TA) studies.

Activities associated with a visit to any facility for a compliance inspection shall not be double counted. Thus, a single visit cannot be counted as both a CSI and a CEI; it must be reported as one or the other. However, a single visit that encompasses separate activities (e.g., a PAI or legal support investigation) will be reported and counted as two separate activities. A compliance monitoring inspection (all types) is not considered complete until the appropriate portions of the Compliance Inspection Report Form (EPA Form 3560-3) have been completed and the information from the coding section entered into the permit compliance system (PCS).

Inspection Notification

Generally, CSIs and CEIs are conducted unannounced unless there is a reason to conduct the inspection on an announced basis. Routine PAI's and DE's are typically announced inspections due to the complexity of the logistics involved in these types of investigations.

2.5.2 CWA Inspection Types

Compliance Evaluation Inspection (CEI)

The CEI is a nonsampling inspection designed to verify permittee compliance with applicable permit self-monitoring requirements, effluent limits, and compliance schedules. This inspection involves records reviews, visual observations, and evaluations of the treatment facilities, laboratories, effluents, receiving water, etc. The CEI examines both chemical and biological self-monitoring and forms the basis for all other inspection types except the Reconnaissance Inspection. Guidance for conducting CEIs is given in the NPDES Compliance Evaluation Inspection Manual (2).

Compliance Sampling Inspections (CSI)

CSI's are conducted where representative sample(s) of a permittee's influent and/or effluent are collected and analyzed 1) to verify the accuracy of the permittee's discharge monitoring reports, 2) to determine the quantity and quality of the effluent, 3) to develop permits, and/or 4) where appropriate, as evidence for enforcement proceedings. This activity also includes the same objectives listed for CEI's, and where appropriate, may serve to gather detailed information for the possible institution of legal action against the permittee. Guidance for conducting CSI's is given in the NPDES Compliance Sampling Inspection Manual (3).

Toxic Sampling Inspections (XSI)

The XSI has the same objectives as a conventional CSI. However, it places increased emphasis on toxic substances regulated by the NPDES permit. The XSI covers priority pollutants other than heavy metals, phenols, and cyanide, which are typically included in a CSI (if regulated by the NPDES permit). An XSI uses more resources than a CSI because highly sophisticated techniques are required to sample and analyze toxic pollutants. An XSI may also evaluate raw materials, process operations, and treatment facilities to identify toxic substances requiring controls.

Compliance Biomonitoring Inspection (CBI)

A CBI is an inspection utilizing a static or flow-through bioassay, in lieu of, or in addition to, the collection of samples. The objectives of this inspection are to:

- Identify those permittees which may be meeting the minimum technology based requirements of the CWA, but whose level of treatment is not sufficient to ensure the biological integrity of the receiving waters;
- Identify those permittees which may have potential toxic substances in their discharge(s) that have not been identified or included in their NPDES permit; and
- Evaluate compliance with acute or chronic toxicity permit limit requirements.

In those instances where biomonitoring reveals the presence of toxic substances not addressed in the issued permit, the permittee may be required through the 308 process to chemically and/or physically characterize the composition of the discharge to identify and quantify the toxic substance or substances (CWA Section 308). Guidance for conducting these inspections is given in the Compliance Bio-Monitoring Inspection Manual (4).

Performance Audit Inspection (PAI)

The PAI is used to evaluate the permittee's self-monitoring program. As with a CEI, the PAI is used to verify the permittee's reported data and compliance through a records check. However, the PAI provides a more resource-intensive review of the permittee's self-monitoring program and evaluates the permittee's procedures for sample collection, flow measurement, chain-of-custody, laboratory analyses, data compilation, reporting, and other areas related to the self-monitoring program. During a CEI, the inspector makes a cursory visual observation of the treatment facility, laboratory, effluents, and receiving waters. During a PAI, the inspector actually observes the permittee performing the self-monitoring process from sample collection and flow measurement through laboratory analyses, data workup, and reporting. The PAI does not include the collection of samples by the inspector. However, the inspector may require the permittee to analyze performance samples for laboratory evaluation purposes.

Diagnostic Evaluations (DE)

The DE is a detailed performance evaluation that focuses primarily on municipal Publicly Owned Treatment Works (POTWs) which are not in compliance with permit requirements. The DE is designed to evaluate the POTW's design, operations, and influent/effluent wastewater characteristics and to provide a comprehensive evaluation of the reasons why the facility is not meeting permit limits. The final product consists of a formal report with data, data interpretation, and recommendations suitable for use in technical assistance, negotiations, and enforcement actions.

Reconnaissance Inspection (RI)

The RI is used to obtain a preliminary overview of a permittee's compliance program. The inspector performs a brief visual inspection of the permittee's treatment facility, effluent, and receiving waters. The RI is intended to obtain a broad coverage of permittees of unknown status with a minimum amount of resources.

Pretreatment Compliance Inspection (PCI)

The PCI evaluates the POTWs implementation of its approved pretreatment program. It includes a review of the POTWs records on monitoring, inspections, and enforcement activities for its industrial users. The PCI is usually conducted concurrently with another NPDES inspection of the POTW.

Sludge Inspection (SI)

The SI is primarily conducted at POTWs. Waste sludge generation and disposal practices are evaluated under the 40 CFR 503 regulations. The SI includes a review of the sludge monitoring records, sludge handling facilities, and sludge disposal practices.

Legal Support Inspection (LSI)

The LSI is an inspection conducted to satisfy a specific enforcement related problem. An example of this type of inspection may be an enforcement request to inspect a permittee to see if it is appropriate to terminate a specific enforcement order or a request to gather data to support a planned action.

2.5.3 Study Plans

Routine NPDES inspections (e.g., PAIs, CSIs, etc.) do not require a written study plan. Detailed investigations, such as diagnostic evaluations, water quality studies, and other large scale technical evaluations require a written study plan which should include the following minimal information:

- Introduction -- The name and location of the project, study dates, requestor, reason for request (e.g., NPDES compliance problems), project leader, and a list of EPA and other appropriate study contacts and telephone numbers.

- Study Objectives -- A detailed description of the primary objectives of the project.

- Sampling Schedule -- A detailed table showing all projected sampling stations, sampling parameters, and the total number of samples to be analyzed.

The study plan may include more detailed information depending on the nature and complexity of the project. Copies of the study plan should be provided to Clean Water Act Section staff.

2.5.4 NPDES Compliance Inspection Reports

The results of all compliance inspections shall be reported utilizing the NPDES Compliance Inspection Report Form (EPA Form 3560-3). The completed form, formal narrative report, and transmittal memorandum constitute a compliance inspection report for all routine compliance inspections conducted by Branch personnel.

The completed inspection reports are forwarded to appropriate parties for action and follow-up. The state and regional program office are kept fully informed via copies of all correspondence. In cases where EPA is involved in litigation with a permittee, no reports will be sent to the permittee without permission from legal counsel.

Completion of NPDES Compliance Inspection Report Form (EPA Form 3560-3)

General instructions for completing EPA Form 3560-3 are printed on the back of the form.

The forms shall be signed by the investigator and dated on the day that the form is completed (not the inspection date). The name of the state inspector should be included for joint inspections. All routine compliance inspections forms shall be reviewed by the supervisor, who will sign and date the 3560-3 form in the "Reviewed By" section.

2.6 Superfund Investigations, Technical Assistance, and Overview Activities

2.6.1 Introduction

Superfund field activities include remedial investigations and feasibility studies (RI/FS), field investigations of potentially or known contaminated areas (FI), technical assistance (TA), and on-site overviews (OV) of Superfund contractor, potentially responsible party (PRP) contractor, and state personnel.

2.6.2 Superfund Investigation Types

Remedial Investigations/Feasibility Studies (RI/FS)

Remedial investigations are conducted to determine the nature and extent of contamination at specific Superfund sites. Investigations may include installation of temporary or permanent monitoring wells, geophysical exploration, surface and subsurface soil sampling, off-site environmental sampling, etc. Feasibility studies may be conducted concurrently with an RI to develop and evaluate potential remedial action alternatives. The Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (5) is useful for planning RI/FS investigations.

Field Investigations (FI)

These include all field investigations, other than RIs, of potentially or known contaminated areas, and they support all phases of the Superfund program. These investigations may include sampling of ground water, surface and subsurface soils, rivers, lakes, etc., and/or may entail geophysical studies, global positioning system (GPS) activities, etc.

Overviews (OV)

Activities include on-site overview of the field work of EPA Superfund field contractors, PRP contractors, and State Superfund contractors. Overviews are conducted to evaluate the contractors' capabilities and to correct deficiencies in performing Superfund field investigations. The Region 4, Hazardous Waste Field Overview Checklist (Exhibit 2.1) is completed during the overview, and a written report presenting the overview findings is completed and transmitted to the appropriate official in the Waste Management Division.

Technical Assistance (TA)

Activities range from directing field investigations with non-Agency field support to responding to telephone questions concerning all aspects of Superfund field investigations. In addition, field personnel provide a variety of training and technical assistance activities for Regional, State, and other Federal agency personnel in methods of conducting field operations at hazardous waste sites.

2.6.3 Planning for Field Investigative Support

Periodic meetings are typically held between a representative(s) of the Superfund Staff and the Waste Management Division staff to discuss proposed initiatives and specific investigation needs. These meetings are usually conducted in October for yearly planning, and more frequently for quarterly planning.

Based on the priorities agreed upon by the Superfund Staff, and the Waste Management Division, field investigation schedules are prepared by the Superfund Staff and updated as needed.

2.6.4 Requests for Superfund Studies

Superfund investigations are prioritized by the Waste Management Division based on the need for field investigative support. Specific investigations are usually requested by project managers of the various Superfund programs, however, they may be requested by state agencies, congressional officials, etc. Routine requests for field investigative support are coordinated with the Superfund Staff leader. Requests are then brought to the Superfund Staff for scheduling and project leader/staff assignment. Although the initial contact may be by telephone or electronic mail, a formal request memorandum with a request form is required prior to commencement of the investigation.

2.6.5 Investigation Study Plans

Study plans are prepared for all Superfund investigations except overviews and some emergency investigations. Study plans for typical Superfund field investigations must be issued at least one week prior to the investigation. The timing and nature of some emergency requests may preclude the issuance of a study plan.

A copy of the study plan in draft form will be provided to the requestor to insure that the plan will meet their objectives. As a general rule, the Data Quality Objective (DQO) process should be consulted during the study plan preparation phase. The study plan should include, as appropriate:

- Introduction -- The project leader and support staff, requestor from the appropriate Superfund Branch, and the objective(s) of the investigation.
- Background -- Facility compliance history, manufacturing processes, types of wastes produced, waste treatment methods, etc.
- Scope -- The study design should be discussed in this section including the number and location of the samples to be collected, information which will be obtained, and records to be reviewed.
- Logistics -- The travel and study dates.
- Methodology -- Analyses to be conducted and who will conduct analyses, field and laboratory SOP references, and when samples will be received by the laboratory.

If the study is an RI, the following additional information, where appropriate, should be included:

- Site background and physical setting
- Initial Evaluation
- Sampling DQO
- Site Management Plan
- Quality Assurance Project Plan
- Field Sampling and Analyses Plan
- Field Health & Safety Plan.

2.6.6 Investigation Reports

Reports will be completed after each investigation and will contain the following, as appropriate:

- Introduction -- When the investigation was conducted; EPA, state, or other regulatory agency participation; facility representatives and what their participation included; who requested the investigation; and the objectives.
- Background -- Study area descriptions, manufacturing process and waste handling priorities, results of previous investigations, etc. A site map depicting major structures and facilities, as well as sampling locations will be included.

- Summary -- A brief summary of the key results and conclusions of the study.

- Discussion -- All aspects pertinent to the investigation, such as analytical results; deficiencies; site hydrology; an evaluation of the monitoring well system; a site map showing monitoring well locations, topography, and ground water flow direction; well depths; and ground water elevations.

- Methodology -- A statement indicating that this SOP was followed and/or reasons why not and whether or not samples were split and with whom.

- Conclusions -- At the discretion of the author, a conclusions section for complex investigations.

- Reference and Appendices -- Laboratory data sheets, checklists, etc.

If the study is an RI, the following additional information should also be included where appropriate:

- Site information, including site description, site history, previous investigation results, regulatory actions, demography, and surrounding land use.

- Sampling strategy.

- Nature and extent of contamination.

- Contaminant fate and transport.

In emergencies, samples are usually collected quickly and analyzed on a fast turn-around basis. In these cases, Team personnel may provide printed copies of sample data to the requestor as soon as practical. Where appropriate, a letter report detailing the field activities associated with the emergency field investigation will be prepared and transmitted to the requestor.

Internal Peer Review and Report Recipients

All Superfund reports will be reviewed internally. Final copies of the report will be sent to the requestor. If facility or state personnel request a copy of the report, this will be indicated in the report transmittal memo. The Regional Superfund program is responsible for distribution of data and reports to site owners or operators and to the public. All requests for such information should be referred to the proper program official for action.

2.7 RCRA Inspections, Investigations, and Overview Activities

2.7.1 Introduction

RCRA field activities include comprehensive ground water monitoring evaluations (CME), RCRA facility assessments (RFAs), case development inspection/evaluations (CDIE) for the RCRA programs and field investigations for the Criminal Investigations Division (CID), and on-site field overviews (OV) of state, RCRA contractor, and federal facility personnel.

2.7.2 RCRA Investigation Types

Comprehensive Ground Water Monitoring Evaluation (CME)

The CME is an overall review of a facility's compliance with all applicable RCRA requirements to determine adequacy of the ground water monitoring system. It includes an on-site examination of records and other documents and an evaluation of the facility's compliance with applicable RCRA requirements. Also evaluated is the effectiveness of the ground water monitoring system and the facility's hydrogeological conditions. Sampling and analysis of the ground water are usually conducted. Guidance for conducting CMEs is included in the RCRA Ground-Water Monitoring Technical Guidance Document (6).

RCRA Facility Assessment (RFA)

The RFA is an agency lead activity which is the first step in a corrective action program. The purpose of the RFA is to identify known and/or probable releases of hazardous wastes or other constituents at solid waste management units (SWMUs) and at previously unaddressed regulated units. It includes a "desk-top" review of information submitted by the owner/operator to EPA and State Agencies. The RFA also consists of an on-site visit, and potentially a subsequent sampling investigation (confirmatory sampling) to determine whether or not releases of hazardous wastes or constituents have occurred. Guidance for conducting the RFA is in the RCRA Facility Assessment Guidance,(7).

Case Development Investigation/Evaluation (CDIE)

These include all RCRA field investigations other than CME's and RFA's, including field sampling investigations, closure/post closure investigations, environmental investigations, trial burns, delisting investigations, etc. The type of investigation dictates the specific field methodology. The CDIE is conducted to gather information on the composition/characteristics of wastes and/or an area impacted by the operation of a RCRA facility. The CDIE may also include verification of a sampling and analysis plan, collection of information on facility design and operation, verification of manifest descriptions, or other unanticipated needs or requests necessary for case development.

Overviews (OV)

Overviews of state RCRA compliance inspections or RCRA contractor inspections are conducted to evaluate their capability to conduct RCRA field investigations. The Region 4, Hazardous Waste Field Overview Checklist (Exhibit 2.1) is completed during the overview, and a written report presenting the overview findings is completed and transmitted to the appropriate EPA regional RCRA official.

2.7.3 Planning for Field Investigative Support

Periodic meetings are typically held between representative(s) of SESD and the RCRA Branch staff to discuss proposed initiatives and specific investigation needs. These meetings are usually conducted in October for yearly planning, and more frequently for quarterly planning. Based on the priorities agreed upon, a tentative field investigation schedule is prepared and updated as needed.

2.7.4 Requests for RCRA Studies

RCRA investigations are prioritized by the Region 4, RCRA programs based on their need for field investigative support. Requests for field investigative support are coordinated with the RCRA team Supervisor or their designee(s). A memorandum with a request form is recommended prior to commencement of the investigation.

2.7.5 Investigation Study Plans

Study plans are prepared for all RCRA investigations and issued at least one week prior to the investigation. A copy of the draft study plan should be provided to the RCRA program requestor to insure that the investigation will meet the enforcement or permitting objectives. As a general rule, the Data Quality Objective (DQO) process should be consulted during the study plan preparation phase. The study plan should include, as appropriate:

- <u>Introduction</u> -- The project leader and support staff, requestor from the RCRA program, and the objective(s) of the investigation.

- <u>Background</u> -- Facility compliance history, manufacturing processes, types of wastes produced, waste treatment methods, etc.

- <u>Scope</u> -- A discussion of the study design including the number and locations of the samples to be collected. Information which will be obtained and records to be reviewed.

- <u>Logistics</u> -- The travel, study dates and personnel.

- <u>Methodology</u> -- Analyses to be conducted and who will conduct analyses, field and laboratory SOP references, and when samples will be received by the laboratory.

2.7.6 Investigation Reports

Reports will be completed after each investigation and will contain the following, as appropriate:

- <u>Introduction</u> -- When the investigation was conducted; EPA, state, or other regulatory agency participation; facility representatives and what their participation included; who requested the investigation; and the objectives.

- <u>Background</u> -- Study area descriptions, manufacturing process and waste handling priorities, results of previous investigations, etc.

- <u>Summary</u> -- A brief summary of the key results and conclusions of the study.

- <u>Discussion</u> -- All aspects pertinent to the investigation e.g., sampling, figures, photographs, analytical results, RCRA deficiencies, etc.

- Methodology -- What information was obtained and from whom, what sampling procedures were used, what analytical methods were used, etc. A statement indicating that this SOP was followed and/or reasons for deviations and whether or not samples were split and with whom.

- Conclusions -- At the discretion of the investigator, a conclusions section for complex investigations.

- Reference and Appendices – Raw data, checklists, etc.

If the study was a CME, the following information should be included where appropriate:

- A discussion of site hydrology.

- An evaluation of the monitoring well system.

- An evaluation of the assessment plan.

- A site map showing monitoring well locations, SWMU's, topography, ground water flow direction, etc.

- Well depth, ground water elevations.

- CME checklist.

Internal Peer Review and Report Recipients

All RCRA plans and reports will be reviewed internally. Final copies of the plan/report will be sent to the requestor. If facility or state personnel request a copy of the report, this will be indicated in the report transmittal memorandum.

2.8 Underground Storage Tank (UST) Investigations

2.8.1 Introduction

USTs were traditionally investigated because of potential, or actual, contamination of the environment from petroleum products. More recently, UST investigations have been conducted because tanks contain hazardous substances. UST field investigations are requested by the Water Management Division, Ground Water/Drinking Water Branch, UST Section and usually involve ground water and/or soil sampling for UST constituents or related products.

UST investigation objectives may include:

- Determining if there has been a release to the environment from the UST.

- Determining if potable wells are contaminated with UST constituents.

- Determining if ground water is contaminated with UST constituents.

- Determining if vicinity soils have been contaminated with UST constituents.

- Determining the direction of the contamination plume and the source of the contamination.

2.8.2 Investigation Study Plans

Study plans are prepared for all UST investigations and must be issued at least one week prior to the investigation. The timing and nature of some emergency requests may preclude the issuance of a study plan.

A copy of the study plan in draft form will be provided to the requestor to ensure that the plan will meet their objectives. As a general rule, the Data Quality Objectives (DQO) process will be consulted during the study plan preparation phase. The study plan should include, as appropriate:

- Introduction – The project leader and support staff, requestor from the UST Section, and the objective(s) of the investigation.
- Background – Facility compliance history, manufacturing processes, types of wastes produced, waste treatment methods, etc.
- Scope – The study design should be discussed in this section including the number and location of the samples to be collected, information which will be obtained, and records to be reviewed.
- Logistics – The travel and study dates.
- Methodology – Analyses to be conducted and who will conduct analyses, field and laboratory SOP references, and when samples will be received by the laboratory.

2.8.3 Investigation Reports

An investigation report containing the following information will be completed:

- Introduction -- When , where and why the investigation was conducted and requesting office. Staff who conducted the investigation.
- Background – Site history, description, and results of previous studies.
- Summary – Summary of the field investigation and resulting analyses, which constituents are present, direction of plume movement if determined, possible sources of contamination, and potable well owners' names, phone numbers, addresses, if appropriate.
- Sketches/maps -- Showing sampling locations, UST locations, direction of plume, etc.
- Methodology – Reference to field and laboratory SOPs

Internal Peer Review and Report Recipients

UST reports will be reviewed internally. Final copies of the report will be sent to the requestor in the UST Section. If private or public potable water supplies are sampled, refer to Section 2.2 for reporting requirements.

2.9 Underground Injection Control (UIC) Investigations

2.9.1 Introduction

Laws protecting ground water from contamination by injection of wastes allow for the sampling of injection wells as well as nearby wells. UIC field investigations are requested primarily by the Region 4, Water Management Division, Ground Water/Drinking Water Branch, GW & UIC Section and usually involves ground water sampling for constituents related to the wastes being injected.

UIC investigation objectives may include:

- Determining if vicinity potable water wells are contaminated with waste products from the injection wells.
- Determining if vicinity ground water monitoring wells are contaminated with waste products from the injection wells.
- Determining the direction of the contamination plume and the source of the contamination.

2.9.2 Investigation Study Plans

Study plans are prepared for all UIC investigations and must be issued at least one week prior to the investigation. The timing and nature of some emergency requests may preclude the issuance of a study plan.

A copy of the study plan in draft form will be provided to the requestor to ensure that the plan will meet their objectives. As a general rule, the Data Quality Objectives (DQO) process will be consulted during the study plan preparation phase. The study plan should include, as appropriate:

- Introduction – The project leader and support staff, requestor from the GW & UIC Section, and the objective(s) of the investigation.
- Background – Facility compliance history, manufacturing processes, types of wastes produced, waste treatment methods, etc.
- Scope – The study design should be discussed in this section including the number and location of the samples to be collected, information which will be obtained, and records to be reviewed.
- Logistics – The travel and study dates.
- Methodology – Analyses to be conducted and who will conduct analyses, field and laboratory SOP references, and when samples will be received by the laboratory.

2.9.3 Investigation Reports

An investigation report containing the following information will be completed:

- Introduction -- When , where and why the investigation was conducted and requesting office. Staff who conducted the investigation.
- Background – Site history, description, and results of previous studies.

- Summary -- Summary of the field investigation and resulting analyses, which constituents are present, direction of plume movement if determined, possible sources of contamination, and potable well owners' names, phone numbers, addresses, if appropriate.

- Sketches/maps -- Showing sampling locations, location of injection well(s), other pertinent information

- Methodology – Reference to field and laboratory SOPs

Internal Peer Review and Report Recipients

UIC reports will be reviewed internally. Final copies of the report will be sent to the requestor in the GW & UIC Section. If private or public potable water supplies are sampled, refer to Section 2.2 for reporting requirements.

2.10 Ambient Air Monitoring Evaluations And Audits

2.10.1 Introduction

In 1979, the US EPA established a plan for obtaining reliable ambient air quality data. The plan includes a network of State and Local Air Monitoring Stations (SLAMS). The regulations governing the network (40 CFR 58) cover the data collection and reporting requirements for state and local air pollution control agencies. The purpose of this section is to provide procedures for the inspection and evaluation of the SLAMS network. Each SLAMS site must meet criteria for network design, instrument exposure, sample inlet, etc.

2.10.2 NAMS/SLAMS Site Evaluations

State and Local Air Monitoring Stations (SLAMS)

A SLAMS network should be designed to meet a minimum of four basic monitoring objectives. Each SLAM site within a network must meet at least one of the following objectives:

- To determine the highest concentrations expected to occur in the area covered by the network.

- To determine representative concentrations in areas of high population density.

- To determine the impact of ambient pollution levels of significant sources or source categories.

- To determine the general background concentration levels.

National Air Monitoring Stations (NAMS)

NAMS are a selected subset of the SLAMS sites, covering urban and multi-source areas. The emphasis is on areas of maximum concentrations and high population density. NAMS, like SLAMS, must conform to EPA siting criteria and operate according to quality assurance procedures that meet or exceed EPA's minimum specifications. The NAMS differ from the SLAMS in that NAMS must use continuous automated instruments for gaseous pollutants.

The NAMS fall into two categories:

- Category (a) - stations in areas of expected maximum concentrations (usually middle scale).

- Category (b) - stations in areas with both poor air quality and high population density. These areas are not necessarily those with expected maximum concentrations. They will usually be densely populated neighborhoods, but may be areas where sensitive individuals are likely to live or work, if such areas are common to the neighborhood.

Urban areas where NAMS are required will usually have both types of stations. It is possible that only one monitoring station will be needed for PM_{10} or SO_2, in which case it must be a Category (a) station.

Network Design

Network design for State and Local Air Monitoring Stations (SLAMS), National Air Monitoring Stations (NAMS), and Photochemical Assessment Monitoring Stations (PAMS) is detailed in Appendix D of 40 CFR 58. Tables 2.10.1 and 2.10.2 show the population levels for which NAMS monitoring is required. The required spatial scales for NAMS are shown in Table 2.10.3. Although SLAMS do not have specific scale requirements, the scales that are appropriate to each pollutant are also shown in Table 2.10.3. Selection of urban areas and actual number of stations per area is jointly determined by EPA and the state agency.

TABLE 2.10.1

GUIDELINES for PM_{10} and SO_2 NAMS NETWORK SIZE
(APPROXIMATE NUMBER of STATIONS PER AREA)

	Population Concentration		
Population Area	High[a]	Medium[b]	Low[c]
>1,000,000	6-10	4-8	2-4
500,000-1,000,000	4-8	2-4	1-2
250,000-500,000	3-4	1-2	0-1
100,000-250,000	1-2	0-1	0

(a) PM_{10}: High concentration areas are those for which ambient PM_{10} data show ambient concentrations exceeding PM_{10} National Ambient Air Quality Standards (NAAQS) by 20% or more.

SO_2: Defined as high when the ambient concentration exceeds the level of the primary NAAQS.

(b) PM_{10}: Ambient concentrations exceed 80% of the NAAQS.

SO_2: Ambient concentrations exceed 60% of the primary or 100% of the secondary NAAQS.

(c) PM_{10}: Ambient concentrations are less than 80% of the NAAQS.

SO_2: Ambient concentrations are less than 60% of the primary or 100% of the secondary NAAQS.

TABLE 2.10.2

POPULATION LEVELS FOR WHICH NAMS MONITORING OF POLLUTANTS OTHER THAN PM_{10} AND SO_2 IS REQUIRED

POLLUTANT	POPULATION
Lead	500,000[a]
CO	500,000
Ozone	200,000
NO_2	1,000,000
$PM_{2.5}$	N/A 35-50 sites total

(a) The minimum is also a SLAMS requirement. NAMS monitoring is also required whenever the NAAQS has been exceeded in any of the last eight quarters.

TABLE 2.10.3
SUMMARY of SPATIAL SCALES USUALLY NEEDED for SLAMS and NAMS

Spatial Scale	Scale Appropriate for SLAMS						
	SO_2	CO	O_3	NO_2	Pb	PM_{10}	$PM_{2.5}$
Micro		X			X	X	X
Middle		X	X	X	X	X	X
Neighborhood	X	X	X	X	X	X	X
Urban	X		X	X	X	X	X
Regional	X		X		X	X	X

Spatial Scale	Scale Appropriate for NAMS						
	SO_2	CO	O_3	NO_2	Pb	PM_{10}	$PM_{2.5}$
Micro		X			X	X	X[1]
Middle					X	X	X[1]
Neighborhood	X	X	X	X	X	X	X
Urban			X	X			X[2]
Regional							X[2]

[1] Only permitted if representative of many such micro-scale environments in a residential district (for middle scale, at least two).
[2] Either urban or regional scale for regional transport sites.

Monitoring Methodology

The monitoring methods that must be used in NAMS/SLAMS are specified in 40 CFR 58, Appendix C (hereafter referred to as Appendix C). Reference methods (or their equivalent) must be used for all regulatory purposes.

An analyzer with a nonconforming range greater than twice the upper limit may be used if it has more than one range. At least one of these ranges must be designated a reference or equivalent method and it must be the one in which the pollutant concentration is likely to occur. Further, the EPA Administrator must determine that the resolution of the range is adequate. See Section 2.6, Appendix C, for further details.

Requests for approval of a sampling method must be submitted to the United States Environmental Protection Agency, National Exposure Research Laboratory (NERL), Human Exposure and Atmospheric Sciences Division (MD-46), Research Triangle Park, North Carolina 27711.

Probe Siting

Probe siting criteria for State and Local Air Monitoring Stations (SLAMS), National Air Monitoring Stations (NAMS), and Photochemical Assessment Monitoring Stations (PAMS) is detailed in Appendix E of 40 CFR 58. Tables 2.10.4 and 2.10.5 display the requirements for probe siting. For further details, clarification, or justification, refer to Appendix E of 40 CFR 58.

Borosilicate glass and FEP Teflon®, or their equivalent, are acceptable materials for SLAMS/NAMS intake sampling lines. FEP Teflon® is not acceptable for VOC and carbonyl sampling at PAMS sites. Borosilicate glass, stainless steel, or its equivalent, are the acceptable probe materials for VOC and carbonyl sampling. The residence time in sampling probes for reactive gases must be less than 20 seconds.

TABLE 2.10.4
SUMMARY of PROBE SITING CRITERIA

Pollutant	Scale	Height Above Ground(m)	Horizontal and Vertical Distance From Supporting Structure [1]	Distance From Trees to Probe	Distance From Roadways to Probe
SO_2 [2,3,4,5]	All	3 - 15	>1	>10	N/A
CO [3,4,6]	Micro All Others	3 ± ½ 3 - 15	>1 >1	>10 >10	2-10 See Table 2.10.5
O_3 [2,3,4]	All	3 - 15	>1	>10	See Table 2.10.5
NO_2 [2,3,4]	All	3 - 15	>1	>10	See Table 2.10.5
Pb [2,3,4,5,7,8]	Micro All Others	2-7 3 - 15	>2 (All Scales, Horizontal Distance)	>10 (All Scales)	See Table 2.10.5
PM_{10} [2,3,4,5,7,8]	Micro All Others	2-7 3 - 15	>2 (All Scales, Horizontal Distance)	>10 (All Scales)	5-15 See 58CFR, App. E
$PM_{2.5}$ [2,3,4,5,7,8]			>2 (All Scales, Horizontal Distance)	>10 (All Scales)	2-10 See 58CFR, App. E

1. When probe is located on a rooftop, this separation distance is in reference to walls, parapets, or penthouses.
2. Should be greater than 20 meters from tree driplines and must be 10 meters from the dripline when trees act as an obstruction.
3. Distance from inlet probe to obstacle, such as buildings, must be at least twice the height the obstacle protrudes above the inlet pole. Sites not meeting this criterion would be classified as middle scale.
4. Must have unrestricted airflow 270 degrees around the inlet probe, or 180 degrees if the probe is on the side of a building.
5. No furnace or incinerator flues should be nearby. Distance is dependent on height of furnace or incineration flues, type of fuel or waste burned, and quality of fuel (sulfur, ash, or lead content). This is to avoid undue influences from minor pollutant sources.
6. The horizontal and vertical distance from supporting structures must be greater than 1 meter. (When the probe is located on a rooftop, this distance is in reference to walls, parapets, or penthouses located on the roof).
7. Must be greater than 10 meters from a street intersection and should be located mid-block.
8. For collocated Pb and PM10 samplers, a 2-4 meter separation distance must be met.
9. Must have unrestricted airflow 270 degrees around the sampler, except for street canyon sites.

TABLE 2.10.5
MINIMUM DISTANCE BETWEEN SAMPLING PROBE and ROADWAYS
(EDGE of NEAREST TRAFFIC LANE)

Roadway Average Daily Traffic (ADT) (vehicles per day)	Minimum Distance Between Roadways and Stations* (meters)		
Neighborhood Scale CO Stations			
<10,000	10		
15,000	25		
20,000	45		
30,000	80		
40,000	115		
50,000	135		
>60,000	>150		
Neighborhood and Urban Scale Ozone and NO_2 Stations			
<10,000	10		
15,000	20		
20,000	30		
40,000	50		
70,000	100		
>110,000	>250		
Lead Stations			
	Micro Scale	Middle Neighborhood, Urban Scale	Regional Scale
10,000	5 - 15	>15 - 50	>50
20,000	5 - 15	>15 - 75	>75
40,000	5 - 15	>15 - 100	>100

* Distances should be interpolated based on traffic flow.

2.10.3 State and Local QA Plan Reviews

Introduction

40 CFR, Part 58, Appendix A specifies the minimum quality assurance (QA) requirements applicable to SLAMS air monitoring data submitted to EPA. The QA Plan for an air monitoring network contains two distinct functions: control of the measurement process and assessment of the quality of monitoring data. The QA Plan must be approved by the Regional Administrator or his designee. In Region 4, the Region's QA Officer has been delegated the authority to approve QA Plans. The SESD Air Monitoring Staff (AMS) has been assigned the responsibility of reviewing QA Plans for SLAMS in Region 4.

Review/Approval Process

The Air Monitoring Staff reviews state and local QA Plans submitted to the Regional Administrator for approval. At a minimum, each QA Plan must include operational procedures for the elements listed in Section 2.0 of 40 CFR Part 58, Appendix A. Based on the review results and comments received from the reviewers, the AMS recommends approval/disapproval action to the Region 4 QA Officer. If the AMS reviewer recommends disapproval of a state or local QA Plan, he/she will hold the review process in abeyance until he/she has requested and received additional information necessary to approve the QA Plan from the state or local agency which submitted the QA Plan.

2.10.4 Performance Audits

Introduction

Performance audits are conducted by the appropriate AMS to assess local and state agencies' quality assurance program. The audits allow for an overall estimate of a given agencies' data quality. However, the result of an audit is not a definitive indicator of the overall quality of an agency's data base.

When scheduling audits with a state or local agency, the state Quality Assurance Coordinator must be notified in advance to allow for state agency representation during the audit. Upon arrival at the audit location, all principles involved must be briefed to explain the audit, its meaning, and the use of its results. Following the initial conference, the audits will be performed. The auditor will ask the station operator to verify that no unscheduled zero or span adjustments have been made prior to the audit. During the audit, the auditor will request the station operator to read the instrument responses from the agency monitor. All data will be recorded on the appropriate audit form.

Following the completion of the audit, an exit conference will be conducted where results of the audit will be discussed. The auditor should not give copies of the audit form to the agency personnel until after returning to the office and after the audit data have been verified. Having verified an auditor's results, copies of the audit form will be sent to the affected agency and state Quality Assurance Coordinator.

All audit gases shall be traceable to National Institute of Standards and Technology Standard Reference Materials (SRMs) or the gases used in the audit may be SRMs or EPA Protocol Gases.

Carbon Monoxide

Carbon monoxide audit concentrations shall be introduced into the monitor prior to any filters, dryers, or mixing chambers. Audit concentration points will be in the following ranges:

Audit Point	Concentration (ppm CO)
1	3 - 8
2	15 - 20
3	35 - 45
4	80 - 90

Note: Audit point #4 will be run only on monitors operated in the 0 to 100 ppm range.

Ozone

Ozone audit concentrations shall be introduced into the monitor at the same point where ambient air enters the sampling system. The audit concentration should be introduced through the probe, if possible. Audit concentration points will be in the following ranges.

Audit Point	Concentration (ppm O_3)
1	0.03 - 0.08
2	0.15 - 0.20
3	0.35 - 0.45
4	0.80 - 0.90

Note: Audit point #4 will be run on monitors operating in the 0 to 1.0 ppm range.

Sulfur Dioxide

Sulfur dioxide audit concentrations shall be introduced into the monitor through the particulate filter. The audit concentration should be introduced through the probe, if possible. Audit concentration points will be in the following ranges:

Audit Point	Concentration (ppm SO_2)
1	0.03 - 0.08
2	0.15 - 0.20
3	0.35 - 0.45
4	0.80 - 0.90

Note: Audit point #4 will only be run on monitors operating in the 0 to 1.0 ppm range.

Nitrogen Dioxide

Nitrogen dioxide audit concentrations shall be introduced into the monitor through the particulate filter. The audit concentration should be introduced through the probe, if possible. Audit concentration points will be in the following range:

Audit Point	Concentration (ppm NO_2)
1	0.03 - 0.08
2	0.15 - 0.20
3	0.35 - 0.45
4	0.80 - 0.90

Note: Audit point #4 will only be run on monitors operating in the 0 to 1.0 ppm range. If the audit is being conducted by gas phase titration (gpt), it will be necessary to run a zero and span point on the monitor's NO_x and NO channels. If NO and/or NO_x data collected by a state/local agency are submitted to the AIRS system, the NO and/or NO_x channel must be audited using either cylinder dilution or gpt.

2.10.5 Air Monitoring Technical System Audit

Introduction

A technical system audit (TSA) is an on-site review and inspection of a state or local agency's ambient air monitoring program to assess its compliance with established regulations governing the collection, analysis, validation, and reporting of ambient air quality data. To promote uniformity in the evaluation of state and local agencies' monitoring programs and performance, the air monitoring staff will use a modified version of the questionnaire (see Appendix H) in "The QA Handbook for Air Pollution Measurement System," Volume II: Part 1, Ambient Air Quality Monitoring Program, Quality System Development, US EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC. (commonly referred to as the "Red Book."). The scope of the systems audit includes an appraisal of network management, field operations, laboratory operations, data management, quality assurance, and reporting. The TSA results should present a clear, complete, and accurate picture of the agency's collection and reporting of ambient air monitoring data.

Frequency of Systems Audits

The EPA Regional Office retains regulatory responsibility to evaluate agency performance on a three-year rotation, unless problems occur. The determination of the extent of the systems audit is left to the Regional Office's discretion.

Selection of Monitoring Sites for Inspection

It is suggested that approximately five percent of a state agency's sites be inspected during a systems audit. For smaller agencies, at least two sites should be inspected. One half of the sites to be inspected should be selected by the agency being audited, while the other half should be selected by the RO audit team.

Data Audits

A complete systems audit must include a review of the data processing and reporting procedures starting at the acquisition stage and terminating at the point of data entry into the AIRS computer system. The guidance for conducting a data audit is given in Appendix 2,Section 2 (5.0 Data and Information Management Audits) of the Red Book.

Guidelines for Conducting Systems Audits of State and Local Agencies

A systems audit should consist of three separate phases:

- pre-audit activities;
- on-site activities; and
- post-audit activities.

Each of these activities is discussed in detail in Sections 15.3.1, 15.3.2, 15.3.3, and Appendix 15, Section 2 of the Red Book. Because of the length of these Red Books sections, they are incorporated by reference.

Audit Reporting

The systems audit report shall include:

- Introduction
- Observations and Recommendations
- Field
- Laboratory
- Data Review
- Conclusion
- Appendix of Supporting Documentation

The report's Appendix of Supporting Documentation contains copies of the completed questionnaire, Corrective Action Implementation Request (CAIR) form, and documentation contributing significantly to the audit results.

2.10.6 National Performance Audit Program

Introduction

Appendix A, Part 2.4 of 40 CFR Part 58 requires agencies operating SLAMS networks to participate in EPA's National Performance Audit Program (NPAP). In addition, agencies receiving Section 105 grants in Region 4 are required to participate in NPAP. The purposes of NPAP are to provide agencies with a means of self-appraisal for the specific operation audit and to provide EPA with an index of the data quality reported to the AIRS data bank.

Air Monitoring Staff

The Air Monitoring Staff's role is to coordinate the NPAP between state and local agencies and EPA's Office of Air Quality Planning and Standards (OAQPS).

Audit Survey

The audit survey is conducted annually on high volume samplers (TSP and PM_{10}) and semi-annually on continuous sampler (SO_2, O_3, NO_2, and CO) and lead (Pb).

2.10.7 $PM_{2.5}$ Federal Reference Method (FRM) Performance Audit Program (PEP)

Introduction

Appendix L, of 40 CFR Part 50 provides the Reference Method for the Determination of Fine Particulate Matter as $PM_{2.5}$ in the Atmosphere. This method provides for the measurement of the mass concentration of fine particulate matter having and aerodynamic diameter less than or equal to a nominal 2.5 micrometers ($PM_{2.5}$) in ambient air over a 24-hour period for purposes of determining whether the primary and secondary national standards for fine particulate matter specified in § 50.6 of this part are met.

Quality assessment procedures are provided in Part 58, Appendix A, and quality assurance guidance are provided in the 1) Quality Assurance handbook for Air Pollution Measurement Systems, Volume I, Principles. EPA/600/R-94/038a, April 1994; 2) Section 2.12 of the Quality Assurance handbook for Air Pollution Measurement Systems, Volume II, Ambient Air Specific Methods, EPA/600/R-94/038b, November, 1998; 3) Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements, (revised edition) EPA/600/R-94/038d, March, 1995.

To achieve the designated Data Quality Objectives (DQO's), Measurement Quality Objectives (MQO's) were designed to evaluate and control measurement uncertainty to tolerable levels. Hence, the Federal Reference Method Performance Evaluation Program (FRM PEP) was implemented to provide a mechanism to understand total measurement bias and compare all environmental data operations against one data operation.

Air Monitoring Staff

The Air Monitoring Staff's role is to:

1. Manage the national work assignment for two ESAT field scientists and one laboratory scientist.

2. Plan and cluster sites on the annual FRM PEP schedules.

3. Provide oversight and communication with the Region 4 State and Local ambient air monitoring agencies.

4. Conduct Technical Systems Audits (TSA) of each reporting organization once every 3 years.

5. Assure that every federal reference method designation within a reporting organization have 25 percent of sites audited (including collocated sites).

6. Assure that at least one monitor in each reporting organization is audited annually.

7. Audit each scheduled SLAM $PM_{2.5}$ monitoring sites at a frequency of 4 times per year.

8. Assure that all FRM and Federal Equivalent Methods (FEM) sampling sites are audited once every four years.
9. Ensure that each site platform can accommodate the portable sampler within 1 to 4 meters of the routine sampler.

10. Review and recommend approval/disapproval of all Quality Assurance Project Plans (QAPP) and Standard Operating Procedures (SOP) for Region 4 State and Local ambient air monitoring agencies.

11. Design, install and manage the operation of the East Coast $PM_{2.5}$ Filter Weighing Laboratory for the client Regions 1, 2, 3, 4, 6, and FRM PEP filters for the State of Washington, Region 10.

12. Act as liaison between and provide technical assistance to the twenty four Region 4 State and Local agencies, OAQPS, and the EPA client Regions.

Audits

In accordance with 40 CFR Part 58, Appendix A, and EPA Quality Assurance Guidance Document 2.12, Section 10.3, the Air Team will conduct TSA on each Region 4 reporting organization, once every 3 years. These audits are designed to assess the entire measurement system and data management activities with regards to the $PM_{2.5}$ monitoring networks. These activities will include the following:

Initial equilibration, weighing, and transportation of the filters to the sampler
Site selection criteria assessment
Equipment installation
Site security
Equipment maintenance
Calibration procedures
Handling and placement of filters
Operation of the sampler and sample collection
Removal, handling, and transportation of the filters from the sampler to the laboratory
Post-sampling equilibration, weighing, storage, and archival of the sampled filters
Data analysis and reporting

An example checklist for the $PM_{2.5}$ TSA is shown in the EPA Quality Assurance Guidance Document 2.12, Section 10.3, pages 10 - 14.

The FRM PEP audits are conducted on 25 percent of the SLAMS monitoring network per reporting organization, and 25 percent of the designated methods used per reporting organization four times per year. Each primary and collocated sampler should receive at least one FRM PEP audit every four years.

2.11 References

1. US-EPA, NPDES Compliance Inspection Manual, United States Environmental Protection Agency, September 1994.

2. US-EPA, NPDES Compliance Evaluation Inspection Manual, MCD-75, United States Environmental Protection Agency, Washington, D.C. 1981.

3. US-EPA, NPDES Compliance Sampling Inspection Manual, MCD-51, United States Environmental Protection Agency, Washington, D.C., 1979.

4. Compliance Biomonitoring Inspections Manual, MCD-62, United States Environmental Protection Agency, Washington, D.C., 1981.

5. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA -- Interim Final; EPA/540/G-89/004.

6. RCRA Ground-Water Monitoring Technical Guidance Document ,United States Environmental Protection Agency, Office of Solid Waste, Washington, D.C., (EPA/530/R-001) November 1992.

7. RCRA Facility Assessment Guidance, United States Environmental Protection Agency Office of Solid Waste, Washington, D.C., (PB87-107769) October, 1986.

EXHIBIT 2.1
REGION 4
HAZARDOUS WASTE FIELD OVERVIEW CHECKLIST

Facility/Site Name						
Address						
Project No.		EPA ID No.				
Facility Contact		Phone No.				
Overview Personnel		Date				
State/Contractor Project Leader						
Affiliation		Phone No.				
Address						
Sampling Personnel						
Other Personnel & Affiliation						
Type of study?						
Study plan issued?		Date issued?				
Study plan reviewed by the Division? Comments:			Acceptable?			
Was study plan followed? Comments:						
Was a safety plan prepared for the study? Comments:						
Was the safety plan adequate? Comments:						
Was the safety plan followed? Comments:						
Additional comments or information:						
Checklist sections completed for this overview:	1.	2.	3.	4.	5.	6.

Key: 1. General Procedures
2. Ground Water Sampling
3. Soil, Sediment, Sludge Sampling
4. Surface Water Sampling
5. Waste Sampling
6. Monitoring Well Installation

SECTION 1 - GENERAL PROCEDURES - SAFETY, RECORDS, QA/QC, CUSTODY, ETC.

1.	Type samples collected? Comments:
2.	Were sampling locations properly selected? Comments:
3.	Were sampling locations adequately documented in a bound field log book using indelible ink? Comments:
4.	Were photos taken and a photolog maintained? Comments:
5.	What field instruments were used during this study? Comments:
6.	Were field instruments properly calibrated and calibrations recorded in a bound field log book? Comments:
7.	Was sampling equipment properly wrapped and protected from possible contamination prior to sample collection? Comments:
8.	Was sampling equipment constructed of Teflon®, glass, or stainless steel? Comments:
9.	Were samples collected in proper order? (least suspected contamination to most contaminated?) Comments:
10.	Were clean disposable latex or vinyl gloves worn during sampling? Comments:
11.	Were gloves changed for each sample station? Comments:
12.	Was any equipment field cleaned? Comments:
13.	Type of equipment cleaned: Comments:
14.	Were proper field cleaning procedures used? Comments:
15.	Were equipment rinse blanks collected after field cleaning? Comments:
16.	Were proper sample containers used for samples? Comments:

17.	Were split samples offered to the facility owner or his representative? <u>Comments</u>:
18.	Was a Receipt for Samples form given to facility representative? <u>Comments</u>:
19.	Were any duplicate samples collected? <u>Comments</u>:
20.	Were samples properly field preserved? <u>Comments</u>:
21.	Were preservative blanks utilized? <u>Comments</u>:
22.	Were field and/or trip blanks utilized? <u>Comments</u>:
23.	Were samples adequately identified with labels or tags? <u>Comments</u>:
24.	Were samples sealed with custody seals after collection? <u>Comments</u>:
25.	What security measures were taken to insure custody of the samples after collection? <u>Comments</u>:
26.	Were chain-of-custody and receipt for samples forms properly completed? <u>Comments</u>:
27.	Were any samples shipped to a laboratory? <u>Comments</u>:
28.	If yes to No. 27, were samples properly packed? <u>Comments</u>:
29.	If shipped to a CLP lab, were Traffic Report Forms properly completed? <u>Comments</u>:
30.	What safety monitoring equipment, protection, and procedures were used prior to and during sampling? <u>Comments</u>:
31.	Was safety monitoring equipment properly calibrated and calibrations recorded in a bound field log book? <u>Comments</u>:

SECTION 2 - SAMPLING - GROUND WATER

1.	Type of wells sampled? (monitoring, potable, industrial,etc.) Comments:
2.	Were wells locked and protected? Comments:
3.	Were identification marks and measurement points affixed to the wells? Comments:
4.	What were the sizes and construction materials of the well casings? Comments:
5.	Were the boreholes sealed with a concrete pad to prevent surface infiltration? Comments:
6.	Was there a dedicated pump in the well? Comments:
7.	Was clean plastic sheeting placed around the wells to prevent contamination of sampling equipment and containers? Comments:
8.	Were total depths and depths to water determined before purging? Comments:
9.	What device was used to determine depths? Comments:
10.	Were measurements made to the nearest 0.01 ft? Comments:
11.	Was the measuring device properly cleaned between wells? Comments:
12.	Was the standing water volume in each well determined? Comments:
13.	How was the volume determined? Comments:
14.	Was a sufficient volume purged prior to sampling? Comments:
15.	How many volumes? Comments:
16.	How was the purged volume measured? Comments:
17.	What was the method of purging? Comments:

18.	Were pH, conductivity, temperature, and turbidity measurements taken and recorded at least once during each well volume purged? Comments:	
19.	Were pH, conductivity, temperature, and turbidity readings stable prior to sampling? Comments:	
20.	How many wells were sampled? Upgradient? Downgradient? Comments:	
21.	How were the samples collected? Bailer Pump Other Comments:	
22.	If a pump was used, what type? Comments:	
23.	If a pump was used, was it properly cleaned before and/or between wells? Comments:	
24.	What were the cleaning procedures? Comments:	
25.	Did bailers have Teflon® coated wire leaders to prevent rope from coming into contact with water? Comments:	
26.	Were bailers open or closed top? Comments:	
27.	Was a clean bailer and new rope used at each well? Comments:	
28.	Were samples properly transferred from the sampling device to the sample containers? (i.e., volatile sample first - not aerated, etc.) Comments:	
29.	Was pH of preserved samples checked to insure proper preservation? Comments:	
30.	Were samples iced immediately after collection? Comments:	
31.	For what analyses were the samples collected? Comments:	
32.	If samples were split, what were the sample/station numbers for these? Comments:	
33.	Are the ground water samples being filtered? Comments:	
34.	If the ground water are being filtered, what procedure is being used? Comments:	

35.	Is low flow/low volume sampling being conducted (e.g., is the intake of the pump at the middle of the screen)? Comments:	
36.	If low flow/low volume sampling is being conducted, is the water level being measured constantly to insure minimal drawdown of the less than 3 to 4 inches? Comments:	
33.	Other comments or observations.	

SECTION 3 - SAMPLING - SOIL, SEDIMENT, SLUDGE, ETC. (Non-containerized)

1.	Type of samples collected? Comments:
2.	General description of samples? Comments:
3.	How many samples were collected? Comments:
4.	Were background and/or control samples collected? Comments:
5.	Were representative samples collected? Comments:
6.	Were grab or composite samples collected? Comments:
7.	Were composite samples areal or vertical? Comments:
8.	How many aliquots were taken for the composite sample? Comments:
9.	What procedures and equipment were used to collect samples? Comments:
10.	Were samples thoroughly mixed prior to putting them into the sample containers? Comments:
11.	Were samples properly placed into sample containers? Comments:
12.	Were samples iced immediately after collection? Comments:
13.	For what analyses were the samples collected? Comments:
14.	If samples were split, what were the sample/station numbers for these? Comments:
15.	Was a drilling rig, back hoe, etc. used to collect soil samples? Comments:
16.	Were the drilling rig(s), backhoe(s), etc., properly cleaned according to the SOP, Appendix B, prior to arriving on site? Comments:
17.	What was the condition of the drilling and sampling equipment when it arrived on site? Comments:

18.	Was a decontamination area located where the cleaning activities would not cross-contaminate clean and/or drying equipment? <u>Comments</u>:
19.	Was clean equipment properly wrapped and stored in a clean area? <u>Comments</u>:
20.	Was the drilling rig(s) properly cleaned between well borings? <u>Comments</u>:
21.	Were the cleaning and decontamination procedures conducted in accordance with the SOP? <u>Comments</u>:
22.	Other comments or observations:

SECTION 4 - SAMPLING - SURFACE WATER (Pond, Stream, River, Leachate, Etc.)

1.	Type of samples collected? Comments:
2.	General description of samples? Comments:
3.	How many samples were collected? Comments:
4.	Were background and/or control samples collected? Comments:
5.	Were grab or composite samples collected? Comments:
6.	How many aliquots were taken for the composite sample? Comments:
7.	What procedures and equipment were used to collect the samples? Comments:
8.	Were samples collected directly into sample containers? Comments:
9.	Did the sampler wade in the stream to collect the samples? Comments:
10.	Were the samples collected upstream from the sampler? Comments:
11.	Did the sampler insure that roiled sediments were not collected along with the water samples? Comments:
12.	Were representative samples collected? Comments:
13.	Was the pH of preserved samples checked to insure proper preservation? Comments:
14.	Were samples iced immediately after collection? Comments:
15.	For what analyses were the samples collected? Comments:
16.	If samples were split, what were the sample/station numbers for these? Comments:
17.	Other comments or observations:

SECTION 5 - WASTE SAMPLING - DRUMS, TANKS, BARRELS, ETC. (Containerized)

1.	What was the objective of the sampling investigation? Comments:
2.	Description of units or sources sampled (closed/open, etc.)? Comments:
3.	General description of samples (Oil, sludge, waste) Comments:
4.	How many samples were collected? Comments:
5.	Were grab or composite samples collected? Comments:
6.	How many aliquots were taken for the composite sample? Comments:
7.	What type of equipment was used to collect the samples? Comments:
8.	What procedures were used to collect the samples? Comments:
9.	Were solid/semi-solid waste samples thoroughly mixed prior to putting them into the sample containers? Comments:
10.	Were samples properly placed into sample containers? Comments:
11.	For what analyses were the samples collected? Comments:
12.	Was equipment field cleaned? Comments:
13.	Was clean equipment properly wrapped and stored in a clean area? Comments:
14.	Were the cleaning and decontamination procedures conducted in accordance with the Appendix B of the EISOPQAM? Comments:
15.	Were the study's objectives accomplished? Comments:
16.	If samples were split, what were the sample/ station numbers for these? Comments:
17.	Were any special safety measures taken during collection of the samples? Comments:

18.	What level of safety protection was required for collection of the samples? Comments:
19.	Other comments or observations:

SECTION 6 - MONITORING WELL INSTALLATION

GENERAL	
1.	Were the wells installed in the proper locations in accordance with the study plan and/or project operations plan (POP)? Comments:
2.	Were the wells installed starting in the least contaminated area and proceeding to the most contaminated area? Comments:
3.	Were proper safety protocols employed during the well installations? Comments:
4.	Were samples of the drilling mud, water, bentonite pellets, filter pack materials, etc., collected for quality control analyses? Comments:
EQUIPMENT DECONTAMINATION	
5.	Were the drilling rig(s), backhoe(s), etc., properly cleaned according to the SOP, Appendix B, prior to arriving on site? Comments:
6.	What was the condition of the drilling and sampling equipment when it arrived on site? Comments:
7.	Was a decontamination area located where the cleaning activities would not cross-contaminate clean and/or drying equipment? Comments:
8.	Was clean equipment properly wrapped and stored in a clean area? Comments:
9.	Was the drilling rig(s) properly cleaned between well borings? Comments:
10.	Were the cleaning and decontamination procedures conducted in accordance with the SOP? Comments:
11.	What type of drilling method(s) was used to install the wells? Comments:
12.	Was this drilling method(s) the same as proposed in the study plan and/or POP? Comments:
13.	Were soil samples collected for logging and analyses as the wells were installed? Comments:
14.	If yes to 13, at what intervals and by what method? Comments:
15.	If air rotary was used, was an in-line organic air filter employed? Was a cyclone velocity dissipator used? Comments:

16.	What diameter borehole(s) were installed? Comments:
17.	Were surface outer casings used? Comments:
18.	If yes to 17, what size and to what depth? Comments:
19.	Were the wells double cased? Comments:
20.	If yes to 19, explain procedure. Comments:
PERMANENT WELL INSTALLATION	
21.	What type of well casing(s) and screen(s) were used? Comments:
22.	What diameter were the well casing(s) Screen(s)? Comments:
23.	Was there a minimum two inch annulus around the casing between casing and borehole was or inside augers)? Comments:
24.	What was the length of the well screen(s)? Comments:
25.	What was the slot size of the well screen(s)? Comments:
26.	Was the well screen(s) commercially manufactured? If so, by whom? Comments:
27.	Was the bottom of the well screen(s) plugged or capped? Comments:
28.	Were sand and/or gravel (filter) packs installed? Comments:
29.	Specify type of materials in 28 [(play sand, Ottawa sand, etc.) and grain size (20/30, 20/40, etc.)], if known. Comments:
30.	Was a sieve analysis conducted to determine well screen slot size and filter pack grain size? Comments:
31.	Were the wells installed to the proper depths? Comments:
32.	Were well screens placed at the proper intervals? Comments:
33.	Were the filter packs placed a minimum of two feet above the well screens? Comments:

34.	Was the tremie tube method used to place the filter packs? Comments:
35.	Were seals placed above the filter packs? Comments:
36.	If yes to 35, what material was used for the seals? Comments:
37.	Was the vertical thickness of the seals a minimum of two feet? Comments:
38.	If bentonite pellets were used for the seals above the filter packs, were they allowed to hydrate a minimum of 8 hours? Comments:
39.	Did contractor/driller have documentation from manufacturer stating recommended hydration time? Comments:
40.	Was the tremie tube method used to place the bentonite pellets? Comments:
41.	Was the annulus grouted from the seal to within two feet of the ground surface, or below the frost line? Comments:
42.	Was the tremie tube method used to place the grout in the annulus? Comments:
43.	If no to 42, what method was used? Comments:
44.	What type of grout was used to seal the annulus (neat cement, cement/bentonite, cement/sand, etc.)? Comments:
45.	What grout mix ratio was used? (should be stated in the POP) Comments:
46.	What was the density of the grout? (lb/gal, etc.) Comments:
47.	If bentonite grout was used, was the density at least 9.4 lb/gal? Comments:
48.	Was the density determined using a mud balance? Comments:
49.	Was the grout allowed to set a minimum of 24 hours before the surface pad was installed? Comments:
50.	Was a concrete surface pad installed with an outer protective casing and locking cap? Comments:
51.	How far below the ground surface did the concrete pad extend? Comments:

52.	What were the dimensions of the concrete pads? <u>Comments</u>:	
53.	Did the well casings extend to a minimum of 2.5 feet above the ground surface? <u>Comments</u>:	
54.	How far above the ground surface did the outer protective casings extend? <u>Comments</u>:	
55.	Did the outer protective casings have weep holes? <u>Comments</u>:	
56.	Were the wells properly developed? <u>Comments</u>:	
57.	Describe method of development. <u>Comments</u>:	
58.	Give a general evaluation of the activities observed during the installation of the wells. <u>Comments</u>:	
TEMPORARY WELL INSTALLATION		
59.	Describe methods and procedures. <u>Comments</u>:	

EXHIBIT 2.2
REGION 4
STATE/CONTRACTOR OVERVIEW CHECKLIST

*** **NOTE** *** This checklist is for overviewing State personnel overviewing a facility or contractor or for overviewing a contractor overviewing contractors.

PART 1

State/Contractor Name	
Address	
Facility/Site Name	
Address	
Facility Contact	Phone No.
Facility Activities/Operations	
Project No.	EPA ID No.
Audit Personnel	Date
State/Contractor Project Leader	
Title	Phone No.
Sampling Personnel	
Other Personnel & Affiliation	
Type of study?	
Study/Work plan issued?	Date issued?
Study/Work plan reviewed by the Division?	Acceptable?
Was the Study/Work plan reviewed by the State/Contractor? Comments:	
Was the study plan followed? Comments:	
Was a safety plan prepared for the study?	
Did the State/Contractor review the safety plan?	
Was the safety plan adequate? Comments:	
Was the safety plan followed? Comments:	
Did the State/Contractor have their own safety plan?	
Did the State/Contractor have a copy of the SOP or have a copy of their own SOP? Comments:	
Was the State/Contractor familiar with the SOP?	
Additional Comments or Information:	

PART 2

1.	Was a field overview checklist completed? <u>Comments</u>:
2.	Was the State/Contractor familiar with the facility and its operations? <u>Comments</u>:
3.	Was the State/Contractor trained in equipment handling and proper sampling techniques? <u>Comments</u>:
4.	Did the State/Contractor observe calibration of safety monitoring and/or field measurement equipment? <u>Comments</u>:
5.	Did the State/Contractor observe all phases of the field investigation such as sampling, field measurements, record keeping, packing and shipping samples, etc.? <u>Comments</u>:
6.	Did the State/Contractor advise sampling personnel regarding improper procedures or practices whenever they were observed? <u>Comments</u>:
7.	Did the State/Contractor assist with the sampling, equipment decontamination or any other phase of the investigation? <u>Comments</u>:
8.	Were there improper procedures or practices used which the State/Contractor failed to recognize? <u>Comments</u>:
9.	Was sampling conducted in accordance with the SOP or other EPA standard operating procedures? <u>Comments</u>:
10.	Was equipment decontamination conducted in accordance with standard operating procedures specified by EPA? <u>Comments</u>:
11.	List any problem areas observed relative to questions #8, #9 or #10: <u>Comments</u>:
12.	What are the qualifications of the investigative/sampling personnel (training and experience) by name? <u>Comments</u>:
13.	Had those personnel received training in sampling techniques and equipment handling? <u>Comments</u>:
14.	When was the latest training received and by whom was it provided? <u>Comments</u>:
15.	What equipment was available and/or used during the investigation? <u>Comments</u>:

16.	Did equipment appear to have been properly cleaned and protected from possible contamination prior to bringing it to the field? Comments:
17.	What type of samples were collected? Comments:
18.	For what analyses were the samples collected? Comments:
19.	Was sampling conducted in accordance with standard operating procedures specified by the State or EPA? Comments:
20.	Did investigative/sampling personnel conduct a comprehensive investigation/evaluation or only collect samples? Comments:
21.	If investigative/sampling personnel only collected samples, how were their sampling efforts coordinated with the rest of the investigation? Comments:
22.	If facility personnel collected samples, did the State/Contractor accept split samples? Comments:
23.	Were adequate field records kept in a bound log book? Comments:
24.	Were photographs taken and a photo log maintained? Comments:
25.	Were QA/QC procedures adequate for the type of study being conducted and type/number of samples being collected? Comments:
26.	Had investigative/sampling personnel received appropriate safety training? Comments:
27.	Do investigative/sampling personnel undergo periodic refresher safety training? Comments:
28.	Did investigative/sampling personnel have appropriate safety equipment for the investigation? Comments:
29.	Are investigative/sampling personnel classified as to the type of investigations they can conduct? Comments:
30.	Have investigative/sampling personnel had comprehensive physicals? Comments:
31.	Do investigative/sampling personnel participate in a medical monitoring program? Comments:
32.	Give a general evaluation of the activities observed during the overview and note any other comments or observations. Comments:

EXHIBIT 2.3
STATE PROGRAM EVALUATION
HAZARDOUS WASTE FIELD ACTIVITIES

State	
Agency	
Specific Activity	RCRA or CERCLA
Location	
Telephone	
Activity Managers	
Evaluator	
Date	

PART 1 -- FIELD ACTIVITY STAFFING				
Description of Field Activity:				
Field Activity Personnel Staffing				
NAME(s)	TITLE	TRAINING	EXPERIENCE	
Field Safety Program and Training:	Personnel categorized as to activity?			
	Does a formal safety training program exist?			
	Does a formal safety training tracking system exist?			
	Does a formal medical monitoring program exist?			
	Safety Training Received?	In-House	Outside	EPA
	Safety Program Needs:			
Field Activity Adequately Staffed to meet Existing RCRA or CERCLA Inspection and Investigation Needs: Adequate Inadequate				
Projected Staffing Needs:				

PART 2 -- FIELD OPERATING PROCEDURES

1. Does a standard operating procedures manual exist or is one being prepared?
Comments:

2. Are inspection schedules and study plans prepared?
Comments:

3. Are these inspections and studies coordinated with the lab?
Comments:

4. Addressed in the SOP?
Comments:

5. Are formal inspection and investigation reports prepared?
Comments:

6. Are the field activities adequately addressed in the SOP Manual?
Comments:

7. Does the SOP address: (Sample Collection)	YES	NO
- Ground Water		
- Surface Water		
- Surface Soil		
- Subsurface Soil		
- Waste - Pits, Ponds, Lagoons		
- Waste - Closed Container		
- Tissue (Fish, etc.)		
- Air		
- QC		

Comments:

8. Does the SOP address: (Sample Handling Techniques)	YES	NO
- Standard Sampling Containers		
- Field Equipment & Sample Container Cleaning Procedures		
- Sample Identification		
- Sample Preservation & Holding Times		
- Sample Chain-of-Custody		
- Sample Packaging Techniques		
- Identification of Hazardous Samples to Lab		
- QC		

Comments:

9.	Does the SOP address: (Field Documentation and Records)	YES	NO
	Field Documentation or Bound Record Books Comments:		
	Photographs Comments:		
	Site Mapping (Sketching of sites) Comments:		

PART 3 -- FIELD CONTRACTORS	
1.	Are field contract personnel used to conduct field investigations? Comments:
2.	What activities do field contractors perform? Comments:
3.	If yes, does a quality control program exist to monitor contractor activities? Comments:

PART 4 - FACILITIES	
1.	Is adequate space provided for the storage of field equipment? Comments:
2.	Are facilities and/or space provided for the cleaning, repair, and preparation of field equipment? Comments:
3.	Specific Facility Needs:

PART 5 - FIELD EQUIPMENT AVAILABLE	
1.	Sampling and Investigative Equipment Available:
	- Field Vehicles
	- Field Analytical Instrumentation
	- Surveying Equipment
	- Photographic Gear
	- Pumps and Automatic Samplers
	- Ground Water Sampling Equipment
	- Surface Water Equipment
	- Sediment Sampling Equipment
	- Soil Coring Equipment
	- Waste Sampling Equipment
	- Geophysical Equipment
	- Temporary Well Installation Equipment
2.	Specific Sampling and Investigation Equipment Needs: Comments:
3.	Safety Equipment Available
	- Monitoring Equipment
	- Protective Clothing
	- Respiratory Protection
4.	Are Safety Procedures available in written form or in a manual? Comments:
5.	Specific Safety Equipment Needs: Comments:
6.	Does a specific field or safety equipment needs list exist? Comments:
7.	Is there an allowance for an equipment budget? Comments:

SECTION 3
SAMPLE CONTROL, FIELD RECORDS, AND DOCUMENT CONTROL

SECTION OBJECTIVES:

- Present standard procedures for sample identification.
- Present standard procedures for sample control.
- Present standard procedures for chain-of-custody.
- Present standard procedures for maintenance of field records and document control.

3.1 Introduction

Sample identification, chain-of-custody records, receipt for sample forms, and field records (with the exception of surveying notes) should be recorded with waterproof, non-erasable ink. If errors are made in any of these documents, corrections should be made by crossing a single line through the error and entering the correct information. All corrections should be initialed and dated. If possible, all corrections should be made by the individual making the error.

If information is entered onto sample tags, logbooks, or sample containers using stick-on labels, the labels should not be capable of being removed without leaving obvious indications of the attempt. Labels should never be placed over previously recorded information. Corrections to information recorded on stick-on labels should be made as stated above.

Following are definitions of terms used in this section:

Project Leader:	The individual with overall responsibility for conducting a specific field investigation in accordance with this SOP
Field Sample Custodian:	Individual responsible for maintaining custody of the samples and completing the sample tags and Chain-of-Custody Record
Sample Team Leader:	An individual designated by the project leader to be present during and responsible for all activities related to the collection of samples by a specific sampling team.
Sampler:	The individual responsible for the actual collection of a sample.
Transferee:	Any individual who receives custody of samples subsequent to release by the field sample custodian.
Laboratory Sample Custodian:	Individual responsible for accepting custody of samples from the field sample custodian or a transferee.

One individual may fulfill more than one of the roles described above.

3.2 Sample and Evidence Identification

PERFORMANCE OBJECTIVE:
• To accurately identify samples and evidence collected.

3.2.1 Sample Identification

The method of sample identification used depends on the type of sample collected. In-situ field samples are those collected for specific field analysis or measurement where the data are recorded directly in bound field logbooks or on the Chain-of-Custody Record, with identifying information, while in the custody of the sampling team. Examples of such in-situ field measurements and analyses include pH, temperature, dissolved oxygen and conductivity. Samples other than those collected for in-situ analysis are identified by using a standard sample tag (Figure 3-3) which are attached to the sample container. In some cases, particularly with biological samples, the sample tag may have to be included with or wrapped around the sample. Sample tags are sequentially numbered and are accountable documents after they are completed and attached to a sample or other physical evidence. The following information shall be included on the sample tag using waterproof, non-erasable ink:

- project number;
- field identification or sample station number;
- date and time of sample collection;
- designation of the sample as a grab or composite;
- a very brief description of the sampling location;
- the signature of either the sampler(s) or the designated sampling team leader and the field sample custodian (if appropriate);
- whether the sample is preserved or unpreserved;
- the general types of analyses to be performed (checked on front of tag); and
- relevant comments (such as readily detectable or identifiable odor, color, or known toxic properties).

Samples or other physical evidence collected during criminal investigations are to be identified by using the "criminal sample tag." This tag is similar to the standard sample tag shown in Figure 3-3, except that it has a red border around the front and a red background on the back of the tag. If a criminal sample tag is not available, the white sample tag may be used and should be marked "Criminal" in bold letters on the tag.

If a sample is split with a facility, state regulatory agency, or other party representative, the recipient should be provided (if enough sample is available) with an equal weight or volume of sample (see Section 2.3.6).

3.2.2 Photograph, Digital Still Image and Video Identification

Photographs and Digital Still Images

When photographs or digital images are taken, a record of each exposure or image shall be kept in a bound field logbook. The following information shall be recorded in the logbook:

- an accurate description of what the photograph or image shows, including the name of the facility or site and the specific project name and project number;
- the date and time that the photograph or image was taken;
- the name of the individual who took the photograph or digital image.

When photographs are used in technical reports or placed in the official files, the film shall be developed with the negatives supplied uncut. The identifying information that was recorded in the field logbook shall be entered on the back of the prints. For criminal investigations, the negatives must be maintained with the bound field logbook in the project file and stored in a secured file cabinet.

When digital images are used in technical reports or placed in the official files, the disk with the original, unaltered file of the images or a printed copy of the unaltered images shall be placed in the official files as well. If printed copies of the images are used, each image shall be identified using the information that was recorded in the field logbook. For enforcement cases, it is imperative that the individual who took the image be identified in the field logbook in the event their testimony is required.

Video

When a video tape is made for use as evidence in an enforcement case, the following information should be recorded in a bound field logbook:

- the date and time that the video was recorded;.
- a brief description of the subject of the video tape;
- the person recording the video.

Video records shall include a visual notation (placard) at the beginning of the of the video with the appropriate information (i.e., location, date, time). An audio record may also be included in the video tape with the above logistical information as well as a narrated description of the video record.

A label shall be placed on the video tape with the appropriate identifying information (i.e., project name, project number, date, location etc.). In the event testimony regarding a video tape recording is required for an enforcement case, one individual should be responsible for recording the video for each case. The original, unaltered tape shall be placed in the official files.

3.2.3 Identification of Physical Evidence

Physical evidence, other than samples, shall be identified by using a sample tag or recording the necessary information on the evidence. When samples are collected from vessels or containers which can be moved (drums for example), the vessel or container should be marked with the field identification or sample station number for future identification, when necessary. The vessel or container may be labeled with an indelible marker (e.g., paint stick or spray paint). The vessel or container need not be marked if it already has a unique marking or serial number; however, these numbers shall be recorded in the bound field log-books. In addition, it is suggested that photographs of any physical evidence (markings, etc.) be taken and the necessary information recorded in the field logbook.

Occasionally, it is necessary to obtain recorder and/or instrument charts from facility owned analytical equipment, flow recorders, etc., during field investigations and inspections. Mark the charts and write the following information on these charts while they are still in the instrument or recorder :

- Starting and ending time(s) and date(s) for the chart.
- An instantaneous measurement of the media being measured by the recorder shall be taken and entered at the appropriate location on the chart along with the date and time of the measurement.
- A description of the location being monitored and other information required to interpret the data such as type of flow device, chart units, factors, etc.

After the chart has been removed, the field investigator shall indicate on the chart who the chart (or copy of the chart) was received from and enter the date and time, as well as the investigator's initials.

Documents such as technical reports, laboratory reports, etc., should be marked with the field investigator's signature, the date, the number of pages, and from whom they were received. Confidential documents should not be accepted, except in special circumstances such as process audits, hazardous waste site investigations, etc.

3.3 Chain-of-Custody Procedures

PERFORMANCE OBJECTIVE:

- To maintain and document the possession of samples or other evidence from the time of collection until they or the data derived from the samples are introduced as evidence.

3.3.1 Introduction

Chain-of-custody procedures are comprised of the following elements: 1) maintaining custody of samples or other evidence, and 2) documentation of the chain-of-custody for evidence. To document chain-of-custody, an accurate record must be maintained to trace the possession of each sample, or other evidence, from the moment of collection to its introduction into evidence.

3.3.2 Sample Custody

A sample or other physical evidence is in custody if:

- it is in the actual possession of an investigator;
- it is in the view of an investigator, after being in their physical possession;
- it was in the physical possession of an investigator and then they secured it to prevent tampering; and/or
- it is placed in a designated secure area.

3.3.3 Documentation of Chain-of-Custody

Sample Tag

A sample tag (Figure 3-3) should be completed for each sample using waterproof, non-erasable ink as specified in Section 3.2.

Sample Seals

Samples should be sealed as soon as possible following collection using the EPA custody seal shown in Figure 3-5. The sample custodian should write the date and their initials on the seal. Except for criminal investigations, the use of custody seals may be waived if field investigators keep the samples in their custody as defined in Section 3.3.2 from the time of collection until the samples are delivered to the laboratory analyzing the samples. Custody seals will always be used for criminal investigations.

Chain-of-Custody Record

The field Chain-Of-Custody Record (Figure 3-1) is used to record the custody of all samples or other physical evidence collected and maintained by investigators. All physical evidence or sample sets shall be accompanied by a Chain-Of-Custody Record. This Chain-Of-Custody Record documents transfer of custody of samples from the sample custodian to another person, to the laboratory, or other organizational elements. To simplify the Chain-of-Custody Record and eliminate potential litigation problems, as few people as possible should have custody of the samples or physical evidence during the investigation. This form shall not be used to document the collection of split samples where there is a legal requirement to provide a receipt for samples (see Section 3.4). The Chain-Of-Custody Record also serves as a sample logging mechanism for the laboratory sample custodian. A separate Chain-of-Custody Record should be used for each final destination or laboratory used during the investigation.

All information must be supplied in the indicated spaces (Figure 3-1) to complete the field Chain-Of-Custody Record. The reverse side of the Chain-of-Custody Record (Figure 3-2) describes the requirements for station ID, sample ID and media codes

- All samplers and sampling team leaders (if applicable) must sign in the designated signature block.
- One sample should be entered on each line and not be split among multiple lines.
- If multiple sampling teams are collecting samples, the sampling team leader's name should be indicated in the "Tag Number" column (or adjacent to this column) for the appropriate sample(s).

- If the individual serving as the field sample custodian is different from the individual serving as the project leader, the field sample custodian's name and the title of the sample custodian (e.g., Jane Doe, Sample Custodian) should be recorded in the "Remarks/Air bill" block at the top of the Chain-of-Custody Record. The "Remarks/Air bill" block may also be used to record Air bill numbers or registered or certified mail serial numbers.

- The total number of sample containers for each sample must be listed in the "Total Containers" column. The number of individual containers for each analysis must also be listed in the respective column. Required analyses should be circled or entered in the appropriate location as indicated on the Chain-of-Custody Record.

- The tag numbers for each sample and any needed remarks should be in the "Tag Numbers" column.

- The sample custodian and subsequent transferee(s) should document the transfer of the samples listed on the Chain-of-Custody Record. The person who originally relinquishes custody should be the sample custodian. Both the person relinquishing the samples and the person receiving them must sign the form. The date and time that this occurs should be documented in the proper space on the Chain-of-Custody Record.

- Usually, the last person receiving the samples or evidence should be the laboratory sample custodian or their designee(s).

The Chain-of-Custody Record is a serialized document. Once the Record is completed, it becomes an accountable document and must be maintained in the project file. The suitability of any other form for chain-of-custody should be evaluated based upon its inclusion of all of the above information in a legible format.

If chain-of-custody is required for documents received during investigations, the documents should be placed in large envelopes, and the contents should be noted on the envelope. The envelope shall be sealed and an EPA custody seal placed on the envelope such that it cannot be opened without breaking the seal. A Chain-Of-Custody Record shall be maintained for the envelope. Any time the EPA seal is broken, that fact shall be noted on the Chain-Of-Custody Record and a new seal affixed. The information on the seal should include the sample custodian's initials and the date.

Physical evidence such as video tapes or other small items shall be placed in Zip-Loc® type bags or envelopes and an EPA custody seal should be affixed so that they cannot be opened without breaking the seal. A Chain-Of-Custody Record shall be maintained for these items. Any time the EPA seal is broken, that fact shall be noted on the Chain-of-Custody Record and a new seal affixed. The information on the seal should include the sample field custodian's initials and the date.

EPA custody seals can be used to maintain custody of other items when necessary by using similar procedures as those previously outlined in this section.

Samples should not be accepted from other sources unless the sample collection procedures used are known to be acceptable, can be documented, and the sample chain-of-custody can be established. If such samples are accepted, a standard sample tag containing all relevant information and the Chain-Of-Custody Record shall be completed for each set of samples.

3.3.4 Transfer of Custody with Shipment

- Samples shall be properly packaged for shipment in accordance with the procedures outlined in Appendix D.

- All samples shall be accompanied by the Chain-Of-Custody Record. The original and one copy of the Record will be placed in a plastic bag inside the secured shipping container if samples are shipped. When shipping samples via common carrier, the "Relinquished By" box should be filled in; however, the "Received By" box should be left blank. The laboratory sample custodian is responsible for receiving custody of the samples and will fill in the "Received By" section of the Chain-of-Custody Record. One copy of the Record will be retained by the project leader. The original Chain-of-Custody Record will be transmitted to the project leader after the samples are accepted by the laboratory. This copy will become a part of the project file.

- If sent by mail, the package shall be registered with return receipt requested. If sent by common carrier, an Air Bill should be used. Receipts from post offices and Air Bills shall be retained as part of the documentation of the chain-of-custody. The Air Bill number or registered mail serial number shall be recorded in the remarks section of the Chain-Of-Custody Record.

3.4 Receipt for Samples Form (CERCLA/RCRA/TSCA)

PERFORMANCE OBJECTIVE:

- To assure that staff comply with environmental laws which require providing a Receipt for Samples Form.

3.4.1 Introduction

Section 3007 of the Resource Conservation and Recovery Act (RCRA) of 1976 and Section 104 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) of 1980 require that a "receipt" for all facility samples collected during inspections and investigations be given to the owner/operator of each facility before the field investigator departs the premises. The Toxic Substances Control Act (TSCA) contains similar provisions. The laws do not require that homeowners or other off-site property owners be given this form.

3.4.2 Receipt for Samples Form

The Receipt for Samples form (Figure 3-4) is to be used to satisfy the receipt for samples provisions of RCRA, CERCLA, and TSCA. The form also documents that split samples were offered and either "Received" or "Declined" by the owner/operator of the facility or site being investigated. All information must be supplied in the indicated spaces to complete the Receipt for Samples form.

- The sampler(s) must sign the form in the indicated location. If multiple sample teams are collecting samples, the sample team leader's name should be indicated in the "EPA Sample Tag No./Remarks" column.

- Each sample collected from the facility or site must be documented in the sample record portion of the form. The sample station number, date and time of sample collection, composite or grab sample designation, whether or not split samples were collected (yes or no should be entered under the split sample column), the tag numbers of samples collected which will be removed from the site, a brief description of each sampling location, and the total number of sample containers for each sample must be entered.

- The bottom of the form is used to document the site operator's acceptance or rejection of split samples. The project leader must sign and complete the information in the "Split Samples Transferred By" section (date and time must be entered). If split samples were not collected, the project leader should initial and place a single line through "Split Samples Transferred By" in this section. The operator of the site must indicate whether split samples were received or declined and sign the form. The operator must give their title, telephone number, and the date and time they signed the form. If the operator refuses to sign the form, the sampler(s) should note this fact in the operator's signature block and initial this entry.

The Receipt for Samples form is serialized and becomes an accountable document after it is completed. A copy of the form is to be given to the facility or site owner/operator. The original form must be maintained in the project files.

3.5 Field Records

PERFORMANCE OBJECTIVE:

- To accurately and completely document all field activities.

Each project should have a dedicated logbook. The project leader's name, the sample team leader's name (if appropriate), the project name and location, and the project number should be entered on the inside of the front cover of the logbook. It is recommended that each page in the logbook be numbered and dated. The entries should be legible and contain accurate and inclusive documentation of an individual's project activities. At the end of all entries for each day, or at the end of a particular event, if appropriate, the investigator should draw a diagonal line and initial indicating the conclusion of the entry. Since field records are the basis for later written reports, language should be objective, factual, and free of personal feelings or other terminology which might prove inappropriate. Once completed, these field logbooks become accountable documents and must be maintained as part of the official project files. All aspects of sample collection and handling, as well as visual observations, shall be documented in the field logbooks. The following is a list of information that should be included in the logbook:

- sample collection equipment (where appropriate);
- field analytical equipment, and equipment utilized to make physical measurements shall be identified;
- calculations, results, and calibration data for field sampling, field analytical, and field physical measurement equipment;
- property numbers of any sampling equipment used, if available;
- sampling station identification;
- time of sample collection;
- description of the sample location;
- description of the sample;

- who collected the sample;
- how the sample was collected;
- diagrams of processes;
- maps/sketches of sampling locations; and
- weather conditions that may affect the sample (e.g., rain, extreme heat or cold, wind, etc.)

3.6 Document Control

PERFORMANCE OBJECTIVE:

- To assure that project files are maintained in accordance with Divisional guidelines.

Document control refers to the maintenance of inspection and investigation project files. All information below shall be kept in project files. Investigators may keep copies of reports in their personal files, however, all official and original documents relating to inspections and investigations shall be placed in the official project files. The following documents shall be placed in the project file, if applicable:

- request memo from the program office;
- copy of the study plan;
- original Chain-Of-Custody Records and bound field logbooks;
- copy of the Receipt for Sample forms;
- records obtained during the investigation;
- complete copy of the analytical data and memorandums transmitting analytical data;
- official correspondence received by or issued by the Branch relating to the investigation including records of telephone calls;
- photographs and negatives associated with the project;
- one copy of the final report and transmittal memorandum(s); and
- relevant documents related to the original investigation/inspection or follow-up activities related to the investigation/inspection.

Inappropriate personal observations and irrelevant information should not be placed in the official project files. At the conclusion of the project, the project leader shall review the file to ensure that it is complete.

3.7 Disposal of Samples or Other Physical Evidence

PERFORMANCE OBJECTIVE:

- To ensure that proper disposal procedures are used for samples or other evidence.

Disposal of samples or other physical evidence obtained during investigations is conducted on a case-by-case basis. Before samples which have been analyzed are disposed of, the ASB sample custodian shall contact the project leader via E:mail, indicating that the samples will be disposed of by a certain date unless the project leader dictates otherwise. If the sample custodian does not receive a message from the project leader within the time specified in the E:mail, the samples will be disposed of. Personnel should check with the EPA Program Office requesting the inspection or investigation before granting permission to dispose of samples or other physical evidence. The following general guidance is offered for the disposal of samples or other physical evidence:

- No samples, physical evidence, or any other document associated with a criminal investigation shall be disposed of without written permission from EPA's Criminal Investigations Division.

- Samples associated with routine inspections may be disposed of following approval from the project leader. Sample tags will be discarded along with the samples.

3.8 Field Operations Records Management System (FORMS)

PERFORMANCE OBJECTIVE:

- To introduce the procedure for streamlining sample documentation

FORMS is a computer program designed to streamline the documentation required by SESD and/or the Contract Laboratory Program (CLP) for sample identification and chain-of-custody. Once the appropriate information is entered into the computer, FORMS will generate stick-on labels for the sample tags and sample containers (CLP), and will generate sample receipt forms and chain-of-custody records for the appropriate laboratory. The advantages to this system include faster processing of samples and increased accuracy. Accuracy is increased because the information is entered only once, and consequently, consistent for the tags, bottle labels, sample receipt forms and chain-of-custody records. Operating instructions are available for use with the FORMS program.

FIGURE 3-1
CHAIN-OF-CUSTODY FORM

EPA REGION 4
U.S. ENVIRONMENTAL PROTECTION AGENCY

CHAIN OF CUSTODY RECORD

SCIENCE AND ECOSYSTEMS SUPPORT DIVISION
980 COLLEGE STATION ROAD
ATHENS, GEORGIA 30605-2720

PROJECT NO.	PROJECT NAME / LOCATION	SAMPLERS (SIGN)
PROJECT LEADER	REMARKS / AIR BILL	

LAB USE ONLY	STATION ① ID	SAMPLE ② ID	③ MEDIA CODE	20__ DATE	TIME	COMP OR GRAB	REMARKS	TOTAL CONTAINERS	COD, TOC, NUTRIENTS	BOD, SOLIDS	METALS	EXT ORG / PEST / PCBs	VOA	CYANIDE				TAG NUMBER

RELINQUISHED BY: (PRINT)	DATE:	RECEIVED BY: (PRINT)	RELINQUISHED BY: (PRINT)	DATE:	RECEIVED BY: (PRINT)
(SIGN)	TIME:	(SIGN)	(SIGN)	TIME:	(SIGN)

DISTRIBUTION: White and Pink copies accompany sample shipment to laboratory; Pink copy retained by laboratory.
White copy is returned to samplers. Yellow copy retained by samplers.

4A-03954 (6/98)

FIGURE 3-2
MEDIA CODES

① **<u>Station ID</u> - Station ID is required *if* positional data is recorded for the sample.** Any combination of letters, numbers, or other characters. Maximum of 20 characters. Use this column to identify a sampling station where one or more samples or field measurements are taken. A few examples are well numbers, NPDES permit numbers, Air permit numbers, AOC numbers, Grid numbers, Site designations, etc., or combinations of these as appropriate.

② **<u>Sample ID</u> - Required.** Any combination of letters or numbers. Maximum of 8 characters. **NOTE: For QA/QC samples, the Sample ID <u>must</u> begin with the letters "QA for the sample to be properly identified.**

③ **<u>Media Code</u> - Required.** Choose the code that most closely describes the sample:

Environmental Samples

SF -Surface Soil (0"-12")
SB -Subsurface Soil (>12")
PW -Potable Water
MS -Municipal Water Supply
IW -Industrial Well
WA -Waste
SW -Surface Water
SD -Sediment
GW -Groundwater
PC -Precipitation
OT -Other (Unknown)
OB -Other Biota
MP -Municipal Proc. Wastewater
IP -Industrial Proc. Wastewater

WP -Wipe Sample
FI -Fish Sample
VG -Vegetation
MI -Macroinvertebrates
WW -Wastewater
SL -Sludge (non-RCRA)
UI -UIC Injection Wells
US -Underground Storage Tanks
PT -Petroleum Tanks
AA -Ambient Air
IA -Indoor Air
ME -Municipal Eff. Wastewater
IE -Industrial Eff. Wastewater
PE -Periphyton
TI -Tissue

Field QA/QC Samples

TS -Trip Blank-Soil
TW -Trip Blank-Water
TP -Trip Blank-Wipe
EB -Equipment Rinse Blank
GR -Grout Blank
MB -Drilling Mud Blank
DB -Potable Decon Blank
BB -Bentonite Blank
FA -Field Blank Air

FB -Filter Sand Blank
OW -Organic Free Water Blank
PB -Preservative Blank
GB -Glove Blank
BO -Bottle Blank
FL -Field Blank
IB -Dry Ice Blank
BK -Other Blank

BL -Blender Blank

FIGURE 3-3
SAMPLE TAG

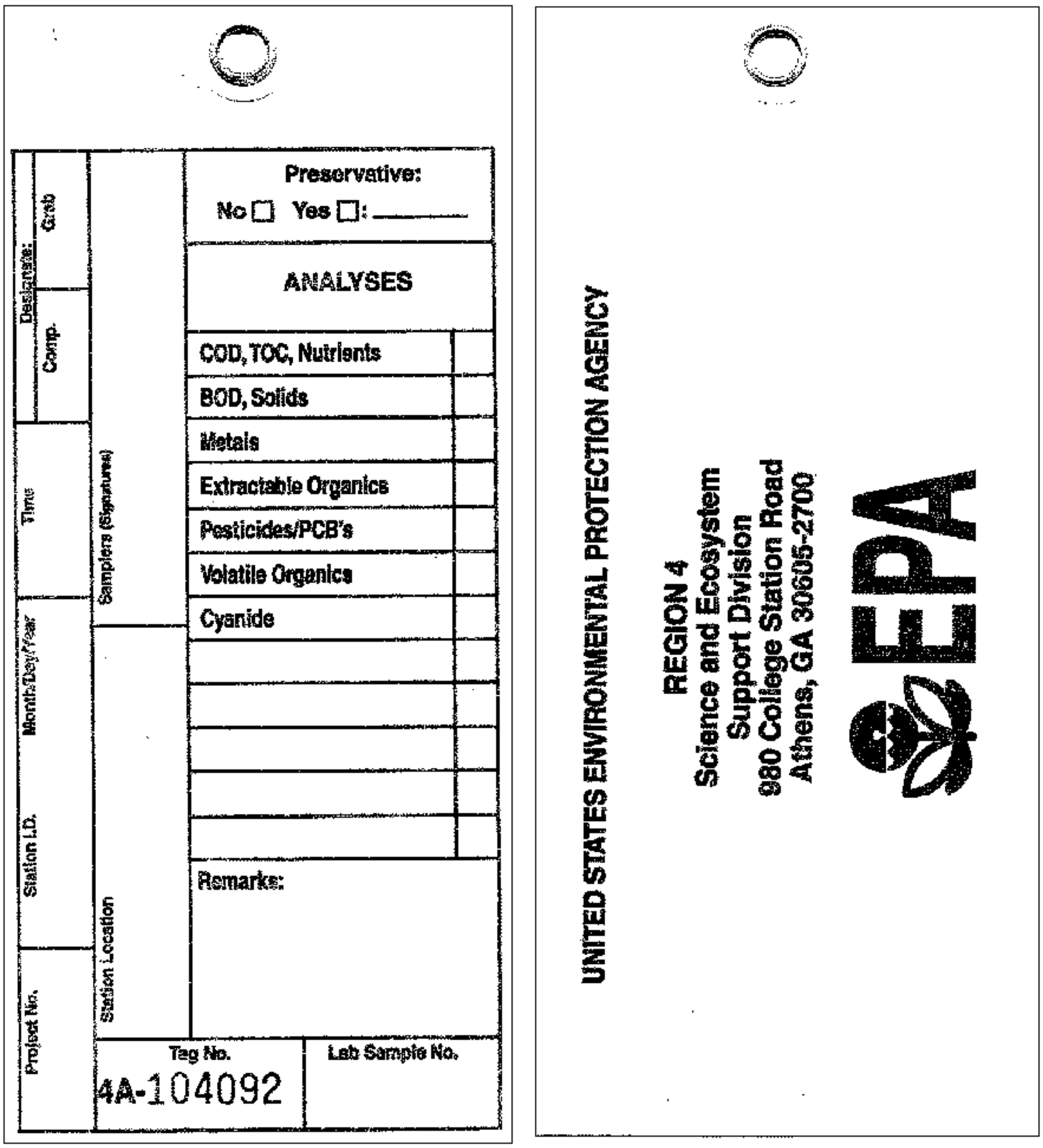


FIGURE 3-4
RECEIPT FOR SAMPLES FORM

US EPA REGION 4
960 COLLEGE STATION ROAD
ATHENS, GEORGIA 30605-2720

RECEIPT FOR SAMPLES

PROJECT NO.	PROJECT NAME	NAME & LOCATION OF FACILITY/SITE
SAMPLERS: (SIGNATURE)		

STATION NO.	19__ DATE	TIME	COMP	GRAB	STATION LOCATION/DESCRIPTION	NO. OF EPA CONTAINERS	SPLIT SAMPLES Y OR N	EPA SAMPLE TAG NO.S/REMARKS

SPLIT SAMPLES TRANSFERRED BY: (PRINT)	DATE	SPLIT SAMPLES RECEIVED BY ☐ OR DECLINED BY ☐ (PRINT)	DATE/TIME
(SIGN)	TIME	(SIGN)	TELEPHONE
		(TITLE)	

DISTRIBUTION: Original to Coordinator Field Files: Copy to Facility/Site Representative

*U.S. GOVERNMENT PRINTING OFFICE: 1990-531-617 (12/89)

No. 4 4609

FIGURE 3-5
EPA CUSTODY SEAL

United States **Environmental Protection Agency** **Athens, Georgia** **REGION 4**		**Date** __________ **Initial** __________	**OFFICIAL** **SAMPLE** **SEAL**

SECTION 4
BRANCH SAFETY PROTOCOLS

SECTION OBJECTIVE:

- Present safety protocols to ensure that all operations are conducted in a manner which protects worker safety and meets compliance with all OSHA regulations and EPA safety policies.

4.1 Introduction

The following parts of this section define safety protocols that are to be used by Branch investigators while conducting field operations. This section also covers the necessary training, equipment, and experience that is needed to conduct safe environmental investigations at hazardous waste sites.

The Division safety program is jointly coordinated by the Occupational Health and Safety Designee (OHSD); a Division Safety, Health and Environmental Manager (SHEM) coordinator; and a Branch safety officer. The OHSD appoints the SHEM to perform the following duties: 1) classify employees into safety categories based upon the type of work they are engaged in; 2) make requests for hazardous duty status; 3) provides and tracks safety related training; 4) notifies management of safety deficiencies; and 5) reviews project specific safety plans. The employees immediate supervisor is responsible for ensuring that their employees meet training and medical monitoring requirements. Specific projects will include a Site Safety Officer (SSO) whose responsibility is to ensure that the site safety plan is adhered to during the course of work. Other SSO responsibilities and duties are listed in Section 4.3.1. Responsibility for the safe conduct of site operations is ultimately the responsibility of each individual worker.

Field investigators will not be required to participate in any operation which violates OSHA and EPA regulations/guidance. The safety protocols in this section are written in accordance with those defined by the following regulations, guidance documents, and manuals;

<u>29 CFR Part 1910.120, Hazardous Waste Operations and Emergency Response</u>: These OSHA regulations govern workers at hazardous waste sites and include requirements for training, equipment, and practices involved in handling of hazardous materials.

<u>29 CFR Part 1910.1200, Hazard Communication</u>: These OSHA regulations govern workers handling hazardous materials and include requirements for training, labeling, and documentation involved in handling hazardous materials.

<u>29 CFR Part 1910.134, Respiratory Protection:</u> These OSHA regulations govern the use and maintenance of respiratory protection equipment used by personnel handling hazardous wastes.

<u>Occupational Safety and Health Guidance Manual for Hazard Waste Activities</u>: This NIOSH, OSHA, USCG, and EPA guidance manual is for those who are responsible for occupational safety and health programs at hazardous waste sites. It assumes a basic knowledge of science and experience in occupational safety and health. It is the product of four Agencies (NIOSH, OSHA, USCG, and EPA) mandated by CERCLA section 301 (f) to study the problem of protecting the safety and health of workers at hazardous waste sites.

Field Health and Safety Manual: USEPA, Region IV, 1990: This manual covers safety involved in all field activities performed in Region 4. It includes regional policy regarding training requirements, medical monitoring, and personal protection.

Safety, Health and Environmental Management Program Procedures and Policy Manual: This manual covers safety practices and rules governing activities at SESD facilities and field sites.

The remaining parts of this section cover hazard communication, safety protocols, training, and equipment that are to be used when conducting hazardous waste investigations.

4.2 Hazard Communication Procedure

4.2.1 Introduction

The purpose of this hazard communication procedure is to ensure that the hazards of all chemicals used by the Branch are evaluated, and that information concerning their hazards are transmitted to Branch personnel. The transmittal of information is to be accomplished by means of a comprehensive hazard communication program which includes container labeling and other forms of warning, material safety data sheets (MSDS), and employee training.

4.2.2 Scope

This hazard communication procedure covers activities involving the use and storage of hazardous chemicals.

4.2.3 Labels and Other Forms of Warnings

Personnel responsible for receiving and storage of hazardous chemicals from manufacturers and suppliers will ensure that the containers are marked with the following information:

- Identity of the hazardous chemical(s);
- Appropriate hazard warnings; and
- Name and address of the chemical manufacturer, importer, or other responsible party.

Containers of hazardous chemicals generated during field investigations will be labeled with the following information:

- Identity of the hazardous chemical(s) contained therein; and
- Appropriate hazard warnings.

Exempt from labeling requirements are any containers into which hazardous chemicals are transferred from labeled containers, and which are intended only for use by the person who performs the transfer during the same work day which the transfer is made. Labels on containers or hazardous chemicals will not be removed or in any way defaced. Labels for containers of hazardous chemicals will be provided by the SHEM or a designee. Information on the labels will be in English. Information in other languages may be added as long as the information presented in English is in no way obscured.

4.2.4 Material Safety Data Sheets (MSDSs)

Personnel responsible for receiving hazardous chemicals from manufacturers or suppliers will ensure that MSDSs are obtained for each shipment received. Receipt of hazardous chemicals will be contingent upon both the provision of MSDSs and compliance of the MSDS with requirements set forth in OSHA's Hazardous Communication Final Rules, part (g).

The Branch Safety Officer or a designee will ensure that current MSDSs are available on the Lan and the following locations:

- The Field Equipment Center;
- Battery Charging Shed; and
- All field vehicles used to transport hazardous chemicals or used as mobile laboratories where such hazardous chemicals are utilized.

Access to MSDSs on the Lan is accomplished by the following procedure:

<u>MSDS Access</u>

The following instructions cover basic use of the MSDS system. If you encounter problems or if you have any questions, please call Jim Gray at X8613.

1. In LAN Windows, double click on the SESD Applications Icon, then double click on the OHS Database Icon.

2. Once the program is loaded, use any key to go through the Title, Warning and Disclaimer screens. At the Main Screen, press F2 to activate the Pull Down Menu. The Select Data Base function will be highlighted. Scroll right to the SEARCH Pull Down Menu. The Enter Query function will be highlighted. Press ENTER to activate the Query screen.

3. The first line of the Query screen asks for the Chemical Name. For example, type in Nitric Acid. DO NOT PRESS THE ENTER KEY AFTER TYPING IN THE CHEMICAL NAME. Press F3 for the search. The search screen will eventually show 1 document found. After 10 or so seconds, the MSDS will appear.

4. You can navigate through the MSDS by using Page Up/Down or by scrolling with the arrow keys, but it is slow. The recommended method is to press F7 which activates the Jump To pull down menu. In this menu, highlight the information you want and press ENTER. For example, you want to make up a HazComm label for a container of Nitric Acid. In the Jump To menu, scroll down to HAZARDS IDENTIFICATION and press enter. After a few seconds, that portion of the MSDS will be displayed showing the NFPA numbers to enter on the label. Now suppose you want to know how to store your newly labeled container of nitric acid. Press F7 again to activate the pull down Jump To menu. Scroll to HANDLING AND STORAGE and press enter. The screen will display the portion of the MSDS dealing with handling and storage. If you would like to know what the incompatibles are that the MSDS keeps referring to, Press F7, and on the Jump To menu scroll to STABILITY AND REACTIVITY then press ENTER. The screen will display the types of things and a list of specific things that nitric acid should be kept separate from (and why).

5. If you would like to print the MSDS, press F2 for the Menu. Scroll down to PRINT DATA and press the ENTER key. The MSDS will print out on the network printer you have selected for your PC.

6. To exit the program, press F2 for the Menu. Scroll down to EXIT and press the ENTER key.

Finally, here are a few suggestions to help you when doing a search. Take the example of methylene chloride. If you try this one by following the instructions given above, you will find that the search will find 0 documents. This does not mean there is no MSDS for methylene chloride, it means that the program calls it something else. When you encounter a situation like this, delete the name you have typed into the CHEMICAL NAME space. Scroll down to TRADE NAME/SYNONYM and retype the name, in this case methylene chloride. You will find the search gives you 12 documents found. Upon review of the documents, you can see that the program calls methylene chloride, dichloromethane. By selecting that name from the 12 given, you will get the correct MSDS.

When using TRADE NAME/SYNONYM for a search, you can get over a hundred documents to search. By far the easiest and most direct way to search is by CAS Number. If you need a CAS number, call an ASB chemist or call the SHEM.

4.2.5 The Hazardous Chemical Inventory

The Branch Safety Officer or a designee will compile a list of hazardous chemicals used or stored within the Branch. The list will include the following:

- Name used in-house for the chemical or mixture of chemicals;
- Correct chemical name for the chemical or each component of a mixture of chemicals;
- Location(s) of the chemical; and
- Location(s) of the posting of MSDSs related to the chemical or mixture of chemicals.

The Hazardous Chemical Inventory will be updated quarterly and reported to the Chemical Hygiene Officer (CHO).

Employee Information and Training

The Branch safety officer or a designee will insure that personnel are provided with information and training on hazardous chemicals in their work area at the time of their initial assignment, and whenever a new hazard is introduced into their work area.

Information provided to personnel will consist of the following:

- Requirements of this Hazard Communication Procedure;
- Operations in their work area where hazardous chemicals are present; and
- Location and availability of this Hazard Communication Procedure in this SOP, the Hazardous Chemical Inventory List on the LAN, and the locations of MSDSs as stated in Section 4.2.4.

Training provided to personnel will consist of:

- Methods and observations that may be used to detect the presence or release of a hazardous chemical in the work area (e.g., monitoring conducted by the Branch Safety Officer or a designee, continuous monitoring devices, visual appearance or odor of hazardous chemicals when being released, etc.);

- The physical and health hazards of the chemicals in the work area;

- Measures such as appropriate work practices, emergency procedures, and personal protective equipment to be used by personnel to protect themselves from these hazards, and specific procedures to be implemented to protect them from exposure to hazardous chemicals; and

- The details of this Hazard Communication Procedure, including an explanation of the labeling system and the MSDSs, and how personnel can obtain and use the appropriate hazard information.

4.3 Safety Protocols

4.3.1 Site Safety Officer Duties

The following is a list of duties that are required for an individual designated to be a Site safety officer (SSO). Branch safety protocols are to be administrated by the Division's Occupational Health and Safety Designee (OHSD) and the appointed Division Safety, Health, and Environmental Manager (SHEM). Safety protocols are to be followed by the SSO as well as each individual that is a part of the investigation. Safety during hazardous waste site investigations begins with the individual. However, it is the responsibility of the SSO to plan and coordinate the following during an investigation:

1. Ensure that each member of the investigative team is up to date on their site safety training (i.e. Annual Safety Refresher, CPR and First Aid) or has received an over-ride by the OHSD.

2. Meet with the project leader to gain knowledge of site operations and sampling strategies.

3. Prepare and enforce the site safety plan.

4. Make sure that necessary project specific safety equipment is available and operational. This includes checking out air monitoring instruments to ensure that they are fully operational, charged, and calibrated; for Level B operations - checking cool vest batteries and pumps, filling and checking self contained breathing apparatus (SCBA) air tanks and/or the airline system.

5. The SSO is also responsible for oversight of safety during the investigation. This oversight can include the following duties - safety sweep with air monitoring instruments at the commencement of the site investigation, directing the set-up of the command post and work zones (decontamination, exclusion, and contaminant reduction zones), and calibrating (or verifying such) and operating air monitoring instruments during the investigation, and conduct medical monitoring for heat stress throughout the operation.

4.3.2 Safety Equipment

Investigators will be provided with the following safety equipment as appropriate:

- rain suit
- snow suit and ski mask
- work gloves
- safety glasses (prescription if necessary)
- hearing protection
- hard hat
- steel toe/shank safety boots (leather and rubber)
- first aid supplies.

Field investigators will be responsible for properly operating and maintaining the safety equipment in the field. Should the safety equipment malfunction or be broken, field investigators are responsible for reporting the condition to appropriate personnel at the Field Equipment Center (FEC) upon its return. The report will include as accurate a description or account of the problem as possible.

Field investigators will not operate any equipment for which they have not received training or have insufficient familiarity to conduct safe operations.

Activities which will require a familiarization exercise for personnel prior to the actual execution of the work include:

- Enclosed area entry;
- Level A, B, or C operations;
- Drilling or power augering;
- Drum openings;
- Brush cutting with power equipment;
- Boat operations;
- Generator operations; and
- Steam cleaning.

4.3.3 OSHA Confined Space Entry

According to 29 CFR Part 1910.146 an individual must have a permit to enter a space that meets the following definition for a confined space. Confined space means a space that is: 1) large enough and so configured that an investigator can bodily enter and perform assigned work; 2) has limited or restricted means for entry or exit (e.g., tanks, vessels, silos, storage bins, hoppers, vaults, or pits are spaces that may have limited means of entry); and 3) is not designed for continuous occupancy. Field investigators shall not enter a space if it meets this definition.

4.3.4 Entry into Enclosed Areas

When conducting hazardous waste site investigations in areas that do not meet the definition in OSHA 29 CFR Part 1910.146 or that are enclosed (areas that could potentially trap explosive vapors and/or have depleted oxygen), field investigators should monitor the atmosphere of the area to identify immediately dangerous to life and health (IDLH) and other dangerous conditions. Examples of dangerous conditions that may be encountered when working around enclosed areas (other than those listed in 29 CFR Part 1910.146) include areas that may support flammable or explosive atmospheres, oxygen-deficient environments, and highly toxic levels of airborne contaminants. Some examples of enclosed areas that field investigators may enter after conducting appropriate air monitoring include, building interiors (if possible the field investigator(s) should attempt to ventilate the enclosed area by opening doors and windows), trenches (less than 3 feet deep), low lying areas in tank farms, tractor trailers, sumps, and behind barriers such as tall buildings or tanks. At a minimum, field investigators should use direct reading instruments such as the combustible gas indicator (CGI), oxygen meter, and an organic vapor analyzer (OVA) to monitor the atmosphere in areas that may unexpectedly trap harmful vapors or have a depleted oxygen supply.

4.3.5 Training Status Tracking System

A computer system is used for tracking the status of required safety training for all personnel involved in hazardous waste field operations within the Division. The system tracks the following safety training:

- Medical monitoring physical (annual renewal);
- 40-hour hazardous waste training (no required renewal);
- 8-hour refresher training (annual renewal);
- Cardio-pulmonary resuscitation (CPR) certification (annual renewal);
- First aid certification (tri-annual renewal);
- Fire extinguisher operation (annual renewal);
- International Air Transport Association (bi-annual renewal); and
- Hazard Communication (no required renewal).

It is the responsibility of the Branch safety officer or their designee to notify field investigators or their supervisor when renewals of required training are due. Notification will be no more than 90 days after the actual renewal date. Scheduling training will be the responsibility of each individual unless otherwise stipulated in the notification. Upon scheduling of the training, the individual will notify the Branch safety officer of the date. Upon successful completion of training, a copy of the certificate received will be sent by the individual to the Branch safety officer for inclusion in the safety training file.

In the event that a field investigator's OSHA required training has lapsed by more than 90 days, the individual will not be allowed to enter onto a hazardous waste site. When lapses in training required by EPA policy occur, the individual will be allowed to enter hazardous waste sites at the discretion of the Occupational Health and Safety Designee (OHSD). The individual and their supervisor will be notified of the change in status. Upon successful completion of the required training, the individual and their supervisor will be notified of their return to prior status.

4.3.6 Site Operations

Upon initial entry at a hazardous waste site, a site survey will be conducted. In a facility that has active working employees, the site survey may be conducted in Level D accompanied by air monitoring. At sites that do not have active working employees, the SSO must use discretion when choosing the level of protection that will be used while conducting an initial site survey. All initial site surveys should be conducted using appropriate air monitoring instruments that detect explosive vapors (CGI), oxygen content, and organic vapors (OVA). The purpose of an initial site survey is to accomplish one or both of the following objectives:

- Determine the hazards that may exist which could affect site personnel.

- Verify existing information or obtain new information about the site.

To accomplish the first objective, an assessment of real or potential dangers from fire, explosion, airborne contaminants, radiation, and oxygen deficient atmospheres must be made. This assessment will be made as follows:

- Combustible Gases -- The atmosphere in any location capable of containing or generating a combustible concentration of gases will be monitored with a combustible gas meter. Response of the meter in excess of 25% of the lower explosive limit (LEL) will cause an immediate evacuation of the site.

- Oxygen Deficiency -- A location capable of containing or generating an oxygen deficiency either by depletion or displacement will be monitored with an oxygen meter. Any reading less than 19.5% oxygen will result in the use of self contained breathing apparatus (SCBA).

- Organic Vapors and Gases -- The atmosphere will be monitored with both a photoionization detector (PID) and a flame ionization detector (FID). When appropriate, cyanide gas and halogenated vapors will also be monitored. Any response above background concentrations will cause an upgrade to Level C respiratory protection. Any response above 5 ppm when contaminants are not known, will cause an upgrade to Level B respiratory protection. A response above 200 ppm when contaminants are not known will cause an upgrade to Level A protection.

- Inorganic Vapors and Gases -- There are only a few direct reading instruments with the capability to detect and quantify non-specific inorganic vapors and gases. PIDs have a very limited capability in this area. If specific inorganics are known or suspected of being present, an attempt should be made to provide appropriate monitoring if possible. In the absence of a monitoring capability always assume a worse case scenario and upgrade the level of protection (see below) to a level that gives respiratory and skin protection that is appropriate to a worse case assumption.

- Radiation -- A radiation survey will be conducted of the site. The primary survey instrument will be a Geiger-Mueller detector for beta/gamma radiation. Any response above background will result in evacuation of the area.

Following the initial survey, monitoring will be repeated when new areas of the site are entered, or when operations likely to cause a release are being conducted.

Levels of Personal Protection

Personal protective equipment is divided into four categories based on the degree of protection afforded. The following table compares the relative protection for each level.

	Level A	Level B	LEVEL C	LEVEL D
Respiratory	Maximum	Maximum	Moderate	Minimum
Skin	Maximum	High	Moderate	Minimum
Eye	Maximum	High	Moderate	Minimum

The relationship between air monitoring results and levels of protection (LOP) is shown in the following table.

Instrument	Response	LOP
PID/FID	Background	D
PID/FID	Less than 5 PPM above background	C
PID/FID	5 PPM to 200 PPM	B
PID/FID	Greater than 200 PPM	A
Oxygen	Less than 19.5%	B
CN	Greater than 0 PPM and less than 10 PPM	B
CN	10 PPM or greater	A

NOTE: Measurements from direct-reading air monitors are only one consideration for LOP decisions. If contaminants are known, protection can be achieved at a lesser LOP.

The four levels of protection (ranked from least protective Level D to most protective Level A) and a description of the situations for which each is appropriate is as follows:

LEVEL D	
REQUIRED	Shirt, long pants or coveralls
	Boots with steel toes and shank
OPTIONAL	Gloves
	Rubber boots with steel toe and shank
	Boot covers (disposable)
	Safety glasses, goggles, or face shield (not for chemical splash protection)
	Hard hat
	Emergency Life Support Apparatus (ELSA)
	Thermal/weather protection (coat, overalls, sweater, hat, rain gear, cool vests, and heat stress monitors)
LEVEL D is used when:	The atmosphere contains no known or anticipated hazard.
	Work conditions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

LEVEL C	
REQUIRED	LEVEL D (modified to require chemical resistant boots with steel toe & shank)
	Full-face Air Purifying Respirator (APR) (NIOSH approved)
	Disposable chemical-resistant overalls
	Chemical resistant gloves (inner and outer)
	Emergency Life Support Apparatus (ELSA) (for enclosed area initial entry)
OPTIONAL	Boot covers (disposable)
	Hard hat
	Face shield
	ELSA (for other than initial operations)
	Thermal/weather protection (coat, overalls, sweater, hat, rain gear, cool vests and heat stress monitors)
LEVEL C is used when:	The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect or be absorbed through any exposed skin.
	The types of air contaminants have been identified, concentrations measured, and an air-purifying respirator is available that can remove the contaminants.
	All criteria for the use of air-purifying respirators are met.

NOTE: Level C operations require decontamination of personnel and equipment. Also, zones of protection are required.

Level C is not considered hazardous duty because adequate safety precautions have been taken to reduce the degree of risk.

MODIFIED LEVEL C	
REQUIRED	LEVEL C (modified to include chemically resistant splash suit and triple glove system)
	Cool vests and heat stress monitors (if ambient temperature exceeds 80°F) - see below
	Splash shield
	ELSA (for enclosed area initial entry)
OPTIONAL	Boot covers (disposable)
	Hard hat
	ELSA (for other than initial operations)
	Cool vests and heat stress monitors are optional if ambient temperature is 80°F or less)
Modified Level C is used when:	All requirements for atmospheric contaminants and APR use related to normal Level C have been met.
	Materials being handled require a high degree of splash or contact protection.

NOTE 1: Modified Level C operations require decontamination of personnel and equipment. Also, zones of protection are required.

Modified Level C is not normally considered hazardous because adequate safety precautions have been taken to reduce the degree of risk to a negligible level. Modified Level C could be considered hazardous in a situation where atmospheric contamination was not the determining factor

NOTE 2: When wearing a chemically resistant splash suit (Level B):

- Cool vests are required when wearing a chemically resistant suit for more than 30 minutes and the temperature is 80°F to 90°F.
- Cool vests are required when wearing an chemically resistant suit for more than 15 minutes and the temperature is above 90°F.
- At the discretion of the SSO, a lack of shade may result in the need for cool vests regardless of the temperature.
- Heat stress monitors are optional unless mandated by the SSO.

LEVEL B	
REQUIRED	MODIFIED LEVEL C (without the requirement for splash shield, ELSA, and APR)
	Positive pressure, full-face piece self-contained breathing apparatus (SCBA)/airline system
OPTIONAL	Boot covers (disposable)
	Hard hat
	ELSA
	Cool vests and heat stress monitors (if ambient temperature is 80°F or less)
	Splash shield
Level B is used when:	The type and concentration of atmospheric contaminants have been identified and require the maximum level of respiratory protection, but only a high level of skin protection.
	The atmosphere contains less than 19.5 percent oxygen.
	The presence of incompletely identified vapors or gases is indicated by direct-reading detecting equipment, but the concentrations of contaminants are not suspected of posing a hazard through skin contact.
	The work involves opening containers suspected of containing concentrated wastes where a likelihood of an air release is possible. In this situation, Level B is the initial protection and can be upgraded or downgraded as more information on the nature of the wastes is gathered.

NOTE 1: Level B operations require decontamination of personnel and equipment. Also, zones of protection are required.

Level B operations normally qualify as hazardous duty because the risk of fire/explosion cannot be mitigated.

NOTE 2: When wearing a chemically resistant suit (Level B):

- Cool vests are required when wearing an chemically resistant suit for more than 30 minutes and the temperature is 80°F to 90°F.
- Cool vests are required when wearing an chemically resistant suit for more than 15 minutes and the temperature is above 90°F.
- At the discretion of the SSO, a lack of shade may result in the need for cool vests regardless of the temperature.
- Heat stress monitors are optional unless mandated by the SSO.

LEVEL A	
REQUIRED	LEVEL D (with chemical resistant rubber boots with steel toe and shank)
	Totally-encapsulating chemical-protective suit
	Positive pressure, full face-piece self-contained breathing apparatus (SCBA)/airline system
OPTIONAL	Boot covers (disposable)
	Hard hat
	Cool vests and heat stress monitors (if ambient temperature is 80°F or less)
LEVEL A is used when:	The hazardous substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system.
	Measurements by direct-reading detecting equipment show concentrations high enough to pose a hazard through skin contact.
	Operations are being conducted in confined, poorly ventilated areas not normally intended for human occupation, and conditions requiring a lower level of protection have not been determined (i.e., Levels B, C, or D).

NOTE 1: Level A operations require decontamination of personnel and equipment. Also, zones of protection are required.

Confined space operations require special training and compliance with OSHA permit-required confined space entry procedures.

Level A operations are hazardous duty due to the nature of the equipment worn, and the inability to mitigate the risk of fire/explosion.

NOTE 2: When wearing a totally-encapsulated, chemical-protective suit (Level A):

- Cool vests are required when wearing a totally-encapsulated, chemical-protective suit for more than 30 minutes and the temperature is 80°F to 90°F.
- Cool vests are required when wearing a totally-encapsulated, chemical-protective suit for more than 15 minutes and the temperature is above 90°F.
- At the discretion of the SSO, a lack of shade may result in the need for cool vests regardless of the temperature.
- Heat stress monitors are optional unless mandated by the SSO.

Stress

Field personnel on hazardous waste sites are exposed to both psychological and physiological stress. Psychological stress is countered with adequate training and job proficiency. Physiological stress is primarily due to exposure of the worker to extremes of heat and cold.

Heat Stress

Heat stress can be the result of working during hot weather or wearing protective clothing that inhibits natural ventilation. It can occur even under moderate temperature conditions. Whenever possible, work should be scheduled during cooler parts of the day or night. The following protocols are to be used to counter heat stress:

- Allow workers to replace lost body fluids, water will be available at the site. Liquids for electrolyte replenishment will be available at the discretion of the SSO.
- Cool vests will be made available. Their use will be designated during modified Level C or higher protective level operations when ambient temperatures exceed 80°F or at the discretion of the SSO (see preceding policy).
- At the discretion of the SSO, workers' vital signs will be monitored (i.e., body temperature, blood pressure and heart rate). If deemed necessary by the site safety officer, workers will be fitted with heat stress monitors. Monitoring of vital signs will be mandatory during modified Level C or higher level operations when ambient temperatures exceed 80°F.
- Adequate shade will be provided to shelter workers from direct exposure to the sun during rest periods.
- Work teams will be rotated so that an individuals time on stressful jobs is minimized.
- Field personnel are encouraged to maintain their physical fitness.
- Intake of diuretics (coffee or alcohol) should be minimized prior to field work.

Cold Stress

Exposure to extreme cold can result in hypothermia. Field work during periods of low temperatures and high winds should be conducted to minimize the possibility of hypothermia. The following protocols are to be followed:

- Workers will dress as warmly as possible using the principle of layering their clothing to maximize protection.
- Gloves should be worn when handling metal equipment.
- At the discretion of the SSO, work tours will be limited to minimize exposure to the cold.
- Warm shelter will be made available for workers during breaks. Use of vehicles for warm shelter is discouraged due to the possibility of carbon monoxide exposure.

The SSO will carefully observe workers for signs of hypothermia/frostbite.

Site Control

Site control serves to minimize exposure to contaminants and is accomplished by: 1) providing site security to exclude unnecessary personnel; 2) limiting the number of workers and equipment on-site to the minimum required for effective operations; 3) conducting operations to reduce personal exposure and minimize the potential for airborne dispersion; and 4) implementing decontamination procedures.

Work Zones

To control access of personnel and equipment to possible contaminants, the site will be divided into work zones. Three categories of zones and one command post are utilized. For all operations except Level D, work zones will be designated as follows:

1. Support Zone -- Along with the command post, this is the outermost boundary of the site. Contamination of personnel and equipment in this area is unlikely.

2. Contamination Reduction Zone -- This area serves as a corridor between the exclusion zone and the support zone. All personnel and equipment passing through this corridor from the exclusion zone to the support zone must undergo appropriate decontamination.

3. Exclusion Zone -- This is an area within the support zone, where actual operations are being conducted. Access to this area is limited to personnel and equipment being utilized at that particular time. The risk of contamination in this area is high.

Decontamination

Prior to exiting a hazardous waste site, all personnel and equipment (as needed) must undergo a thorough decontamination. The purpose of this decontamination is twofold. First, it minimizes the transportation of hazardous wastes from a site. Second, it protects workers from exposure which may occur while they are removing their protective equipment.

Decontamination must be conducted in an organized, stepwise manner. If certain pieces of the protective equipment are removed prior to the elimination of potential problems by decontamination, the worker may suffer damage due to inhalation or skin contact with contaminants. It is therefore important that persons doing the decontamination work know the proper procedures and the order in which to perform them to insure that such potential personal injuries do not occur. It is also important that site workers avoid contaminating themselves until after they have been cleared to exit the contamination reduction zone.

Decontamination procedures will generate a quantity of hazardous waste (e.g., contaminated solvents, disposable equipment, etc.) called investigation derived waste - IDW. This material must be handled and disposed of in accordance with Section 5.15.

Level A Decontamination Procedures

Level A operations pose a possibility of hazardous exposure to decontamination workers. Due to the nature of Level A work, personnel in the exclusion zone are likely to have contacted high concentrations of hazardous materials which remain on their protective equipment. Therefore, decontamination workers are required to perform their duties in Level B protection. Following are the Level A decontamination procedures:

1. Immediately upon leaving the exclusion zone, site workers will place all sampling equipment at a designated area provided at the first station. The area will be covered with disposable plastic. Site workers will then proceed to the first decontamination wash tub where their suit, boots, and outer gloves will be thoroughly scrubbed with the appropriate cleaning solution (usually alkaline soap and water). Long handle brushes will be provided for use by the decontamination workers. Decontamination workers should avoid touching the site workers until after they have cleared the rinse station.

2. Site workers' boots and outer gloves will usually be the most contaminated items. Therefore, this step of the decontamination procedure will be accomplished by using soap and water from the washtub/bucket and a brush which is stored in the tub/bucket. In this step, only the boots and gloves of the site worker will be scrubbed. The site workers' suits will be scrubbed using a cleaning solution from a pump sprayer and a brush which is not allowed to contact the more contaminated contents of the washtub/bucket.

3. After clearance from the decontamination personnel, the site worker will proceed to the rinse water washtub/bucket. At this location, the decontamination personnel will scrub the site workers' boots and outer gloves with water from the washtub/bucket using a long handle brush. The site workers' suits will be rinsed with water from a pump sprayer, scrubbed with a brush which has not been allowed to contact the contaminated water in the washtub/bucket, and finally rinsed a second time with water from a pump sprayer.

4. Once cleared by the decontamination personnel, the site worker will exit the rinse tub/bucket area and proceed to a location where the outer gloves and boot covers (if used) will be removed and discarded. Having been decontaminated, the site worker will exit the contamination reduction corridor and enter the support zone. The support zone will be located a distance of at least 25 feet upwind of the last station in the contamination reduction corridor.

5. Once in the support zone, the site workers may receive a fresh cylinder of air, new outer gloves, and new boot covers and return through the contamination reduction corridor to the exclusion zone. If there is to be no immediate return to the exclusion zone, site workers will proceed to the last station. At this location, site workers will remove their boots first, and then remove the suit. Following this, SCBAs and cool vests (if used) will be removed. Each site worker will then clean their SCBA masks with a soap and water rinse, followed by cleaning the inside of the mask with an alcohol wipe. Finally, the site workers will remove their inner glove systems which will be discarded.

6. Decontamination personnel for Level A operations will themselves require decontamination prior to entering the support zone. Decontamination personnel will perform decontamination on each other. A decontamination line separate from the Level A decontamination line will be set up for this purpose. Procedures used on this decontamination line will be those given for Level B decontamination. Under no circumstances will decontamination personnel attempt to perform personal decontamination in the Level A decontamination line.

Level B Decontamination Procedures

Level B operations pose a limited risk of exposure to decontamination personnel. Level B site workers often exit the exclusion zone with moderate levels of contamination on their outer gloves and boots. To a lesser extent, contamination may be present on their splash suits. To protect against exposure to this contamination, decontamination workers will perform their functions in Level C protection.

1. Upon exiting the exclusion zone, site workers will place all equipment in a designated area provided at the first station. The area will be covered with disposable plastic. Following the equipment drop, site workers will proceed to the first decontamination washtub/bucket area where their boots and outer gloves will be thoroughly scrubbed with the appropriate cleaning solution (usually alkaline soap and water). Long handle brushes will be provided for use by the decontamination workers. While at the first decontamination washtub/bucket area, decontamination workers will not attempt to scrub the site workers' suits above chest height. This procedure is to prevent the cleaning solution carrying contaminants from splashing into the open facial area of the impermeable suit. When scrubbing the impermeable suit and SCBA equipment below chest level, decontamination workers will apply water from a pump sprayer and use long handle brushes which have not come into contact with the water in the washtub/bucket. Following this step, decontamination workers will clean areas of the impermeable suit and SCBA above chest level as necessary with paper towels wetted with the cleaning solution from the pump sprayers. Immediately following this step, the decontamination workers will discard their outer gloves and don clean ones. Areas above chest level of the site workers will then be rinsed with clean water from a pump sprayer.

2. Once cleared from the first decontamination washtub/bucket area, site workers will then step into the rinse water washtub/bucket. At this location, decontamination workers will thoroughly scrub the site workers' boots and gloves with water from the washtub/bucket using a long handle brush. The site worker will then be rinsed with water from a pump sprayer. Following this, the decontamination workers will thoroughly scrub site workers (below chest level only) with a long handle brush which is not allowed to contact the contaminated water in the washtub/bucket. Site workers will be rinsed a second time with water from a pump sprayer.

3. Once cleared by decontamination personnel, site workers will exit the rinse tub/bucket and proceed to a location where the outer gloves and boot covers (if used) will be removed and discarded. Having been decontaminated, site workers will exit the contamination reduction corridor and enter the support zone. The support zone will be located a distance of at least 25 feet upwind of the last station in the contamination reduction corridor.

4. Once in the support zone, site workers may receive a fresh cylinder of air, new outer gloves and boot covers then return through the contamination reduction corridor to the exclusion zone. If there is to be no immediate return to the exclusion zone, the site workers will proceed to the last station. At this location, site workers will remove their boots first, then remove their SCBA. Following this, the impermeable suit and cool vest (if worn) will be removed. Each site worker will then clean their SCBA mask with a soap solution and water rinse, followed by cleaning the inside of the mask with an alcohol wipe. Finally, the site workers will remove their inner gloves and discard them.

5. Decontamination personnel for Level B operations will require a minimal amount of decontamination before exiting the contamination reduction zone. This decontamination will consist of a boot rinse in the rinse water washtub/bucket (not the decontamination cleaning solution washtub/bucket), followed by removing the outer gloves and discarding them. If boot covers are worn by decontamination personnel, the boot rinse can be eliminated and the covers can simply be removed and discarded. Decontamination workers can then enter the support zone where new

respirator cartridges, outer gloves, and boot covers can be obtained for return to the contamination reduction corridor. If no immediate return to the corridor is anticipated, decontamination workers can remove their respirators and clean them in a soap wash and water rinse, followed by cleaning the inside of the mask with an alcohol wipe. Their inner gloves will then be removed and discarded.

Level C Decontamination Procedures

Level C operations do not pose a significant risk of exposure to decontamination workers. Therefore, Level D protection is all that is required to be worn when performing decontamination functions.

1. Upon exiting the exclusion zone, site workers will place their equipment in a designated area provided at the first decontamination station. The area will be covered with disposable plastic. Following this, they will proceed to a decontamination cleaning solution washtub/bucket area where decontamination personnel will scrub their boots with a long handle brush. Once cleared from the cleaning solution washtub/bucket area, the site worker will step into a water rinse washtub/bucket. Upon leaving the water rinse tub/bucket, site workers will remove their outer gloves and boot covers (if used) and discard them.

2. Site workers are then clear to enter the support zone where they may obtain new respirator cartridges, outer gloves, and boot covers for return to the exclusion zone. If an immediate return is not anticipated, site workers may remove their respirators. Respirators will be washed in soap solution and rinsed in water. Following this, the inside of the respirators will be cleaned with an alcohol wipe. Finally, site workers will remove and discard their inner gloves.

3. Decontamination personnel may exit the contamination reduction corridor without having to conduct any decontamination upon themselves other than to remove and discard their gloves.

FIGURE 4-1
DECONTAMINATION ZONE FOR LEVELS A AND B

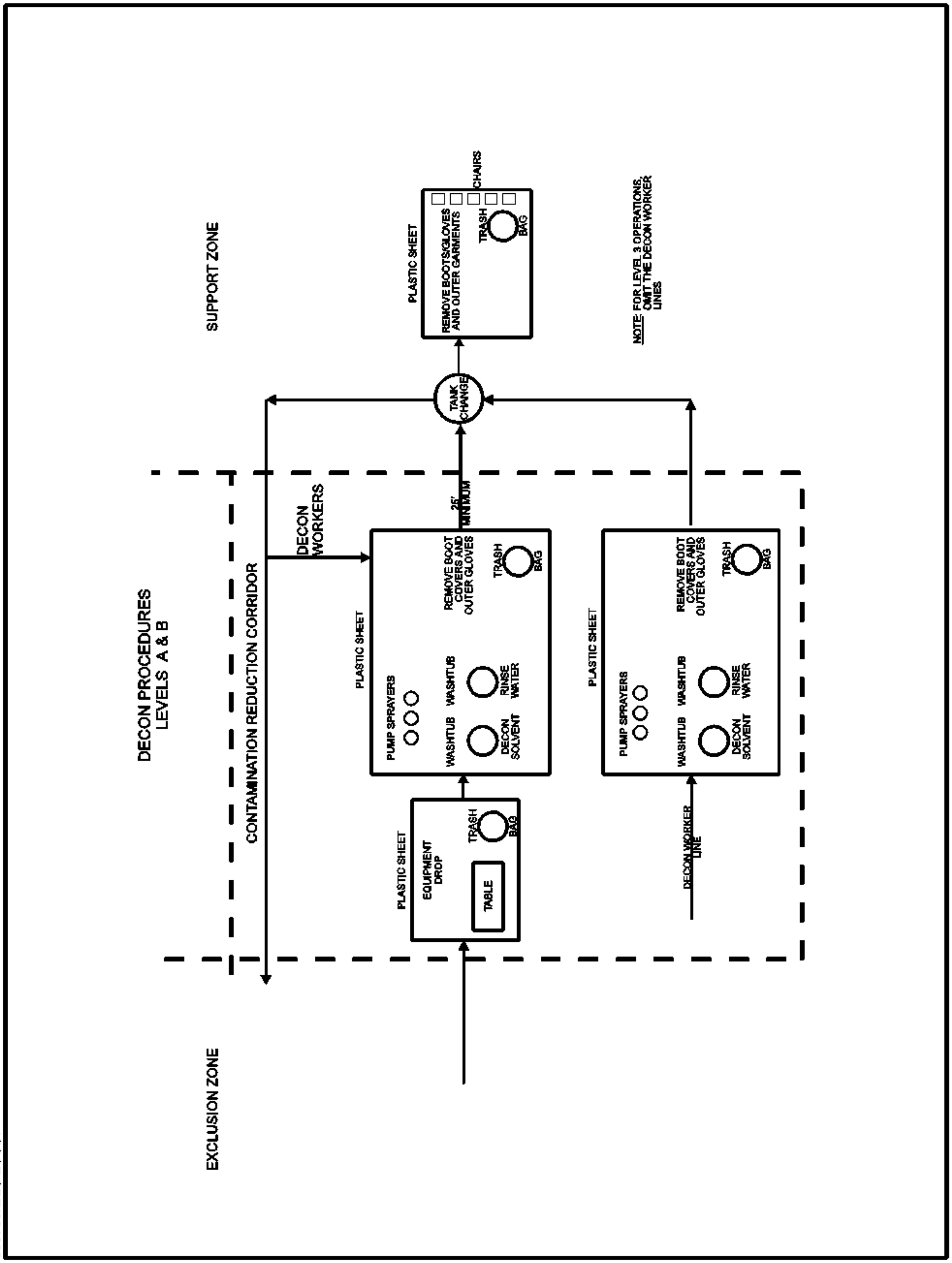
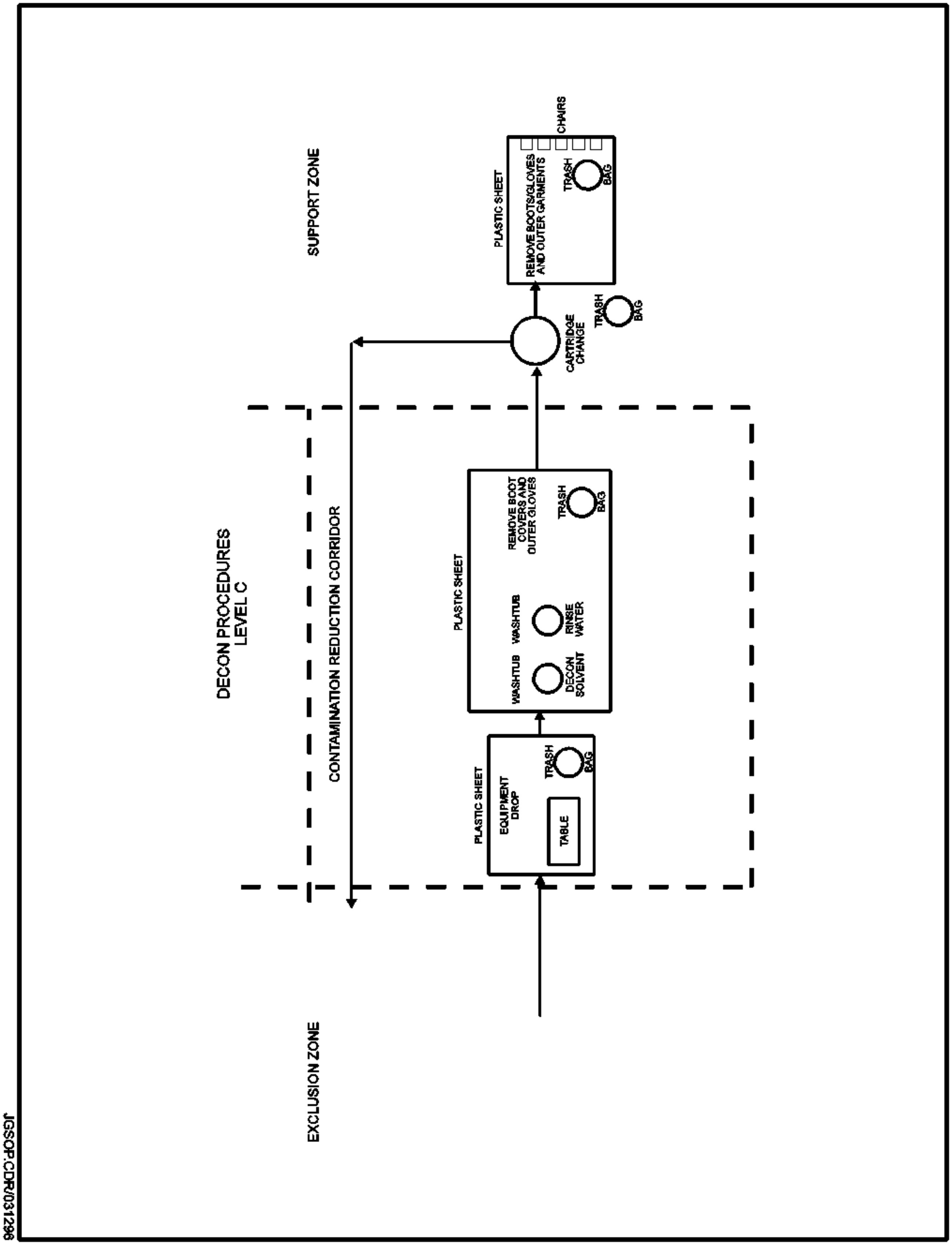


FIGURE 4-2
DECONTAMINATION ZONE FOR LEVEL C



Site Safety Plans

Site safety plans will be developed for every hazardous waste site project conducted. The plan will use the form included in this section. MSDSs will be attached for contaminants anticipated at the site. The plan will be submitted to the Branch safety officer and the OHSD for approval.

Prior to commencing site activities, investigators will be briefed on the contents of the safety plan. The plan's emergency instructions and directions to the closest hospital will be posted in a conspicuous location at the site command post and in each field vehicle. When there is more than one organization involved at the site, the development of the safety plan should be coordinated among the various groups.

**EXHIBIT 4.1
SITE SAFETY PLAN

SAFETY PLAN	
Site Name:	Contact:
Address:	
Phone Number:	
Purpose of Visit:	
Proposed Date of Work:	
Directions to Site:	

SITE INVESTIGATION TEAM:

PERSONNEL *	SAFETY CATEGORY	RESPONSIBILITIES
* All employees have been trained/medically monitored in accordance with OSHA 29 CFR 1910.120 requirements and US-EPA Region IV Field Health and Safety Manual, 1990 edition.		

PLAN PREPARATION:

Prepared by:		Date
Reviewed/Approved by:		Date
Section Chief:		Date

SITE STATUS:

Active	Inactive	Unknown

EMERGENCY INFORMATION:

Local Resources:

Ambulance (Name):	Phone:
Hospital (Name):	Phone:
Police (Local or State):	Phone:
Fire Department:	Phone:

Office Resources:

OFFICE/POINT of CONTACT	WORK PHONE	HOME PHONE
SESD Office - Haz. Waste Section	(706) 355-8603	
EPA - Emergency Response - Atlanta	(404) 562-8700	
SHEM - Betty Kinney	(706) 355-8511	(770) 725-2023
Branch Safety Officer - Jim Gray	(706) 355-8613	(706) 742-8467

EMERGENCY CONTACTS:

Poison Control Center	Phone: (800) 282-5846
National Response Ctr (ENVIRONMENTAL EMERGENCY ONLY)	Phone: (800) 424-8802

Directions to Hospital (Attach Map if Available):

SAFETY AND HEALTH RISK ANALYSIS

Waste Types/Chemicals (Attach MSDS for each):

HAZARD EVALUATION:

Known or Suspected Hazardous/Toxic Materials (If applicable include: PEL/IDLH and/or TLV-TWA/TLV-STEL, LEL, flammability, odor, reactivity, stability, corrosivity)

OVERALL HAZARD:

SERIOUS	MODERATE	LOW	UNKNOWN

SITE PERIMETER ESTABLISHMENT:

Map/Sketch attached?	
Perimeter identified?	
Zone(s) of contamination identified?	

RECOMMENDED LEVEL(S) OF PROTECTION:

Level of Protection: (check those that apply)	LEVEL A	LEVEL B	LEVEL C	LEVEL D

<u>Modifications</u>:

Respiratory:	
Field Dress:	

Monitoring Procedures/Equipment*:

	TVA® 1000 PID/FID		OVA® FID
	Rae® PID		MicroTip® PID
	CN Monitor		Halogen
	Radiation Survey Meter		LEL/Oxygen
	Other, Specify:		

*All instruments are calibrated in accordance with the U.S. Environmental Protection Agency, Region 4, <u>Environmental Investigations Standard Operating Procedures and Quality Assurance Manual</u>, May 1996, or according to the manufacturer's specifications.

Method of Air Surveillance:
Additional Site Specific Information/Stipulations:
Site Decontamination Procedures:

Confined Space Entry (check one)	YES	NO
If yes, define procedures to be used:		

AUGERING and DRILLING OPERATIONS:

Underground Utilities:
All underground utilities must be located prior to commencement of drilling operations involving the drill rig and power augers. Complete the underground utilities checklist below and prepare a site map showing the locations of all underground utilities identified.

UTILITY	LOCATOR/CONTACT PERSON	PHONE #	DATE of LOCATION
Power:			
Telephone: *			
Gas:			
Water:			
Sewer:			
Other:			

* Include non-AT&T lines such as Sprint, MCI, etc.

Above Ground Utilities:
All above ground utilities must be located prior to commencing drilling/augering activities. A map will be prepared showing the locations of all power lines, telephone lines, video cables, guy wires, and other objects which could pose a hazard to personnel operating the drill rig, power auger, or hand auger with multiple extensions. The SSO will insure that all operations are kept well clear of such hazards.

DAILY CHECKS:
Check all proposed drilling locations with a pipe-seeker. As a minimum, the first three feet of a power bored hole will be dug using a post hole digger/hand auger. Personnel involved in the drilling will wear eye and head protection in addition to normal safety gear appropriate for the required level of protection. The SSO will insure that all personnel remove watches, rings, and other jewelry, as well as securing loose fitting or dangling articles of clothing while in the vicinity of the drilling operations. Additionally, the SSO will insure that a 90-degree clear zone is maintained for a radius of at least 6 feet behind the drill rig. The following items will be visually checked daily by the designated driller.

1. All control mechanisms for adjustment, wear and lubrication.
2. Guy wire tension
3. Air and hydraulic systems for deterioration or leakage.
4. Rope reeving.
5. Hoist brakes, clutches and operating levers.
6. Kill switches.

4.3.7 Boating Operations

The skipper must be familiar with the capabilities of their vessel (care and maintenance of engines, batteries, emergency procedures, and rules of navigation as prepared by the United States Coast Guard). The skipper is responsible for everything that happens on the vessel.

When participating in field work, make sure that your field party knows where you will be working (a "float plan") and the expected hour of your return.

When deploying equipment on station make sure that it is secured and not a danger to fellow workers. When the vessel is underway all equipment should be placed in the boat and secured.

Boats need to be checked out through the Boat Log in F107.

Upon return to the SESD facility, all temporary/portable gas cans must be removed from the boats and placed in the Boat Hotel Hazardous Materials Building.

Consumption of alcohol will not be permitted on any boat at any time.

Smoking will not be permitted on any boat at any time.

The law prohibits the throwing, discharging, or depositing of any refuse matter of any kind (including trash, garbage, oil or hazardous substances into the waters of the United States to a distance of three miles from the coastline.

Required Equipment:

Outboard motorboats less than 26 feet in length which are so constructed that entrapment of flammable vapors cannot occur are not required to carry fire extinguishers but they are recommended and should be capable of extinguishing fires involving flammable liquids and grease (class "B" fires).

1) all recreational boats less than sixteen (16) feet in length, including sailboats and rowboats, and all kayaks and canoes, carry at least one Coast Guard Approved Type I, II, III or IV Personal Flotation Device (PFD) for each person on board, and

2) all recreational boats sixteen (16) feet or over in length, including sailboats and rowboats, carry at least one Type I, II, or III (wearable) PFD for each person on board and one Type IV (throwable) PFD in each boat. Weather or working conditions may dictate the wearing of PFD's.

All recreational boats 16 feet or more are required to be equipped with visual distress signaling devices (VDS) at all times when operating on coastal waters. Also, boats less than 16 feet long are required to carry visual distress signals when operating on coastal waters at night. Coastal waters are defined as (1) The ocean (territorial sea) (2) The Great Lakes (3) Bays or sounds that empty into those waters, and (4) Rivers over two miles across at the mouth, upstream to a point where they narrow to two miles. The simplest VDS is a bright orange flag bearing a black square and a black circle (other forms can be found in the U.S. Coast Guard Auxiliary Boating Skills and Seamanship).

Trailering:

Trailering of boats

1. Make sure to use the proper class of hitch for the weight of the trailer being towed;
2. Check to have the proper size coupler for the ball being used;
3. Trailer must have safety chains;
4. A tire-pressure gauge should be used to check tire pressure frequently;
5. Running lights, brake lights and turn signals should be functioning;
6. Every unattached piece of gear in the trailered boat should be firmly secured, and the boat itself should be firmly lashed in place;

A more detailed description of boating regulations and safety can be found in the United States Coast Guard Auxiliary Manual Boating Skills and Seamanship. ISBN #0-930028-03-1

**EXHIBIT 4.2
FLOAT PLAN

Complete this plan, before going boating and leave it with a reliable person who can be depended upon to notify the Coast Guard, or other rescue organization, should you not return as scheduled. Do not file this plan with the Coast Guard.

PROJECT DATES_______________________________________(if overnight, date returning)

1. NAME OF PERSON REPORTING____
   TELEPHONE NUMBER____

BOAT MAKE	COLOR	LENGTH	ENGINES	OCCUPANTS
Wahoo	White	26	IB	
Privateer	White	24	2 OB	
Parker	White	23	2 OB	
Parker	White	21	OB	
Mako	White	20	OB	
Privateer	White	18	OB	
Shocker	Tan	18	OB	
Shocker	Gray	16	OB	
Jon	Gray	14	OB	
Jon	Gray	12	OB	

4. TRIP EXPECTATIONS: LEAVE AT______________________________________(TIME)
   FROM____
   GOING TO____
   EXPECTED TO RETURN BY____(TIME)
   AND IN NO EVENT LATER THAN____(TIME)

5. IF NOT RETURNED BY________________________(TIME), CALL THE COAST GUARD, OR LOCAL AUTHORITY) ________________________________ TELEPHONE NUMBERS
   ____

6. SURVIVAL EQUIPMENT: (CHECK AS APPROPRIATE)
   ____PFDs ____FLARES ____MIRROR ____SMOKE SIGNALS ____EPIRB
   ____CLOTHING ____FLASHLIGHT ____FOOD ____PADDLES
   ____WATER ____OTHERS ____ANCHOR ____RAFT OR DINGHY

7. RADIO:_____YES _____NO
   TYPE______________________________ FREQS.___________________________

8. ANY OTHER PERTINENT INFO:____
   ____

9. FOR SINGLE BOAT OPERATION: AUTOMOBILE LICENSE______________TYPE__________
   TRAILER LICENSE________________________COLOR/MAKE OF
   AUTO___________________
   WHERE PARKED____

10. OTHER:____

4.3.8 FIELD PROCEDURES FOR HANDLING PATHOGENIC SAMPLES:

Whenever there is a possibility that water, soil or sediment may contain pathogenic materials all precautions should be taken to prevent exposure to those collecting and handling the samples.

1. Latex/neoprene gloves shall be worn, as well as boots, waders, and respirators when necessary, for the collection of possible pathogenic samples.

2. After sample collection, gloves will be contained and boots, waders, equipment, etc. used in the sample collection will be decontaminated with soap and water. Hands will be thoroughly washed before proceeding to other tasks.

3. Sample containers shall be cleaned on the outside to help eliminate contamination of handlers in the laboratory and placed in containment if necessary.

SECTION 5
SAMPLING DESIGN AND QUALITY ASSURANCE PROCEDURES

SECTION OBJECTIVES:

- Define planning and quality assurance elements that must be incorporated in all sampling operations.
- Define sampling site selections and collection procedures for individual media.
- Define sampling quality assurance procedures.

5.1 Introduction

This section discusses the standard practices and procedures used by Branch personnel during field operations to ensure the collection of representative samples. Sampling activities conducted by field investigators are conducted with the expectation that information obtained may be used for enforcement purposes, unless specifically stated to the contrary in advance of the field investigation. Therefore, correct use of proper sampling procedures is essential. Collection of representative samples depends upon:

- Ensuring that the sample is representative of the material being sampled.
- The use of proper sampling, sample handling, preservation, and quality control techniques.

5.2 Definitions

<u>Sample</u> -- part of a larger lot, usually an area, a volume, or a period of time.

<u>Representative Sample</u> -- a sample that reflects one or more characteristics of a population.

<u>Sample Representativeness</u> -- the degree to which a set of samples defines the characteristics of a population, where each sample has an equal probability of yielding the same result.

<u>Variability</u> -- the range or "distribution" of results around the mean value obtained from samples within a population. There are three types of variability which must be measured or otherwise accounted for in field sampling.

1. Temporal Variability

   Temporal variability is the range of results due to changes in contaminant concentrations over time. An example would be the range of concentrations obtained for a given parameter in wastewater samples collected at different times from an outfall where contaminant concentrations vary over time.

2. Spacial Variability

   Spacial variability is the range of results due to changes in contaminant concentrations as a function of their location. An example would be the range of concentrations obtained for a given parameter in surface soil from a site where discreet "hot spots" are present due to localized releases of contaminants on otherwise uncontaminated soil.

3. Sample Handling Variability

   Sample handling variability is the range of results due to the sample collection and handling by the sampler. This variability manifests itself as a positive bias due to errors such as unclean sampling equipment, cross contamination, etc., or a negative bias due to improper containers or sample preservation.

<u>Accuracy</u> -- a measure of agreement between the true value and the measured value of a parameter.

<u>Precision</u> -- measure of the agreement among individual measurements of a sample.

<u>Bias</u> -- consistent under or over-estimation of the true value due to sampling errors, sample handling errors, or analytical errors.

<u>Grab Sample</u> -- an individual sample collected from a single location at a specific time or period of time. Grab samples are generally authoritative in nature.

<u>Composite Samples</u> -- a sample collected over a temporal or spacial range that typically consists of a series of discrete, equal samples (or "aliquots") which are combined or "composited". Four types of composite samples are listed below:

1. Time Composite (TC) - a sample comprised of a varying number of discrete samples (aliquots) collected at equal time intervals during the compositing period. The TC sample is typically used to sample wastewater or streams.

2. Flow Proportioned Composite (FPC) - a sample collected proportional to the flow during the compositing period by either a time-varying/constant volume (TVCV) or time-constant/varying volume (TCVV) method. The TVCV method is typically used with automatic samplers that are paced by a flow meter. The TCVV method is a manual method that individually proportions a series of discretely collected aliquots. The FPC is typically used when sampling wastewater.

3. Areal Composite - sample composited from individual, equal aliquots collected on an areal or horizontal cross-sectional basis. Each aliquot is collected in an identical manner. Examples include sediment composites from quarter-point sampling of streams and soil samples from within grids.

4. Vertical Composite - a sample composited from individual, equal aliquots collected from a vertical cross section. Each aliquot is collected in an identical manner. Examples include vertical profiles of soil/sediment columns, lakes, and estuaries.

Quality Control Samples

Quality control samples are collected during field studies for various purposes which include the isolation of site effects (control samples), define background conditions (background sample), evaluate field/laboratory variability (spikes and blanks, trip blanks, duplicate, split samples).

The definitions for specific quality control samples are listed below:

Control Sample -- typically a discrete grab sample collected to isolate a source of contamination. Isolation of a source could require the collection of both an upstream sample at a location where the medium being studied is unaffected by the site being studied, as well as a downstream control which could be affected by contaminants contributed from the site under study.

Background Sample -- a sample (usually a grab sample) collected from an area, water body, or site similar to the one being studied, but located in an area known or thought to be free from pollutants of concern.

Split Sample -- a sample which has been portioned into two or more containers from a single sample container or sample mixing container. The primary purpose of a split sample is to measure sample handling variability. A split sample will also measure inter-or intra-laboratory precision.

Duplicate Sample -- two or more samples collected and representative of a given population. The purpose of a duplicate sample is to estimate the variability of a given characteristic or contaminant associated with a population.

Trip Blanks -- a sample which is prepared prior to the sampling event in the actual container and is stored with the investigative samples throughout the sampling event. They are then packaged for shipment with the other samples and submitted for analysis. At no time after their preparation are trip blanks to be opened before they reach the laboratory. Trip blanks are used to determine if samples were contaminated during storage and/or transportation back to the laboratory (a measure of sample handling variability resulting in positive bias in contaminant concentration). If samples are to be shipped, trip blanks are to be provided with each shipment but not for each cooler.

Spikes,(also known as proficiency test (pt) samples)-- a sample with known concentrations of contaminants. Spike samples are often packaged for shipment with other samples and sent for analysis. At no time after their preparation are the sample containers to be opened before they reach the laboratory. Spiked samples are normally sent with each shipment to contract laboratories only. Spiked samples are used to measure bias due to sample handling or analytical procedures.

Equipment Field Blanks -- a sample collected using organic-free water which has been run over/through sample collection equipment. These samples are used to determine if contaminants have been introduced by contact of the sample medium with sampling equipment. Equipment field blanks are often associated with collecting rinse blanks of equipment that has been field cleaned.

Temperature Blanks -- a container of water shipped with each cooler of samples requiring preservation by cooling to 4°C (ice). The temperature of the blanks are measured at the time of sample receipt by the laboratory. No temperature blank is necessary for samples designated as "waste".

Preservative Blanks -- a sample that is prepared **in the field** and used to determine if the preservative used during field operations was contaminated, thereby causing a positive bias in the contaminant concentration. On studies of short duration, usually only a post-preservative blank is prepared at the end of all sampling activities. On studies extending beyond one week, a pre-preservative blank should also be prepared prior to beginning sampling activities. At the discretion of the project leader, additional preservative blanks can be prepared at intervals throughout the field investigation. These blanks are prepared by putting organic/analyte-free water in the container and then preserving the sample with the appropriate chemical.

Field Blanks -- a sample that is prepared in the field to evaluate the potential for contamination of a sample by site contaminants from a source not associated with the sample collected (for example air-borne dust or organic vapors which could contaminate a soil sample). Organic-free water is taken to the field in sealed containers or generated on-site. The water is poured into the appropriate sample containers at pre-designated locations at the site. Field blanks should be collected in dusty environments and/or from areas where volatile organic contamination is present in the atmosphere and originating from a source other than the source being sampled.

Material Blanks -- samples of sampling materials (e.g., material used to collect wipe samples, etc.), construction materials (e.g., well construction materials), or reagents (e.g., organic/analyte free water generated in the field, water from local water supplies used to mix well grout, etc.) collected to measure any positive bias from sample handling variability. Commonly collected material blanks are listed below:

Wipe Sample Blanks -- a sample of the material used for collecting wipe samples. The material is handled, packaged, and transported in the same manner as all other wipe samples with the exception that it is not exposed to actual contact with the sample medium.

Grout Blanks -- a sample of the material used to make seals around the annular space in monitoring wells.

Filter Pack Blanks -- a sample of the material used to create an interface around the screened interval of a monitoring well.

Construction Water Blanks -- a sample of the water used to mix or hydrate construction materials such as monitoring well grout.

Organic/Analyte Free Water Blanks -- a sample collected from a field organic/analyte free water generating system. The sample is normally collected at the end of sampling activities since the organic/analyte free water system is recharged prior to use on a study. On large studies, samples can be collected at intervals at the discretion of the project leader. The purpose of the organic/analyte free water blank is to measure positive bias from sample handling variability due to possible localized contamination of the organic/analyte free water generating system or contamination introduced to the sample containers during storage at the site. Organic/analyte free water blanks differ from field blanks in that the sample should be collected in as clean an area as possible (a usual location for the organic/analyte free water system) so that only the water generating system/containers are measured.

5.3 Sampling Design

5.3.1 Introduction

Development of a sampling design may follow the seven steps outlined in the EPA publications, "Guidance for the Data Quality Objectives Process" (1) and "Data Quality Objectives Process for Hazardous Waste Sites" (2). The Data Quality Objectives (DQOs) process is a logical step-by-step method of identifying the study objective, defining the appropriate type of data to collect, clarifying the decisions that will be based on the data collected, and considering the potential limitations with alternate sampling designs. Investigations may be executed without completing the DQO process step-by-step; however, the basic elements of the DQO process should be considered by the project leader for each investigation.

Sampling designs are typically either non-probabilistic (authoritative sampling designs) or probabilistic (random sampling designs) in nature. The sampling design ultimately must meet specific study objectives. The location and frequency of sampling (number of samples) should be clearly outlined in the sampling design, as well as provisions for access to all areas of the site, the use of special sampling equipment, etc. Development of the sampling design in the context of DQOs and sampling optimization are discussed in the ASTM documents "Standard Practice for Generation of Environmental Data Related to Waste Management Activities: Development of Data Quality Objectives" (3), and "Standard Guide for the Generation of Environmental Data Related to Waste Management Activities: Quality Assurance and Quality Control Planning and Implementation" (4).

5.3.2 Representative Sampling

A "representative sample" is often defined as a sample that reflects one or more characteristics of the population being sampled. For example, the characteristic which is desired to be reflected by the sample may be the average, minimum, or maximum concentration of a constituent of concern. Ultimately a representative sample is defined by the study objectives. For instance, the objective of the study may be to determine the maximum concentration of lead in the sludge from a surface impoundment. One sample collected near the inlet to the impoundment may provide that information. The collection of a representative sample may be influenced by factors such as equipment design, sampling techniques, and sample handling.

5.3.3 Stratification and Heterogeneous Wastes

Environmental media, as well as waste matrices, may be stratified, i.e., different portions of the population, which may be separated temporally or spatially, may have similar characteristics or properties which are different from adjacent portions of the population. An example would be a landfill that contains a trench which received an industrial waste contaminated with chromium. The trench would be considered a strata within the landfill if chromium was the contaminant of concern. A special case, "stratification by component", is often observed with waste matrices when the constituent of interest is associated with one component of the matrix. An example would be slag contaminated with lead that is mixed with otherwise uncontaminated fire brick. Thus the lead is stratified by component, that being the slag. Stratified sampling designs are discussed later which incorporate independent sampling of each strata, thereby reducing the number of samples required.

Some environmental and waste matrices may be, for purposes of the field investigation, homogeneous (for instance the surface water in a limited segment of a small stream). If the composition of the matrix and the distribution of contaminants are known, or can be estimated, less sampling may be necessary to define the properties of interest. An estimate of the variability in contaminant distribution may be based on knowledge, or determined by preliminary sampling. The more heterogeneous the matrix, the greater the planning and sampling requirements.

A population could also have very localized strata or areas of contamination that are referred to as "hot spots". Specific procedures for hot spot identification and characterization are available in Statistical Methods for Environmental Pollution Monitoring (5).

5.3.4 Specific Sampling Designs

Sampling strategies used by the Branch typically fall into two general groups: **authoritative** or **probabilistic**. Authoritative (also known as directed, subjective, and/or biased) approaches typically rely on the judgement and experience of the investigators, as well as available information on the matrix of concern. Probabilistic, or "statistical" approaches may be appropriate when estimates on uncertainty and specific confidence levels in the results are required. The probabilistic approaches include: simple random sampling, stratified random sampling, and systematic grid sampling. The main feature of a probabilistic approach is that each location at the site has an equal probability of being sampled, therefore statistical bias is minimized. Professional judgement should always be used to develop both authoritative and probabilistic sampling designs.

5.3.5 Determining the Number of Samples to Collect

The number of samples to collect as part of a sampling design will typically be based on several factors, e.g., the study objectives, properties of the matrix, degree of confidence required, access to sampling points, and resource constraints. Practical guidance for determining the number of samples is included in several documents including the ASTM document Standard Guide for General Planning of Waste Sampling (6), the US-EPA document Characterization of Hazardous Waste Sites - A Methods Manual, Volume 1 - Site Investigations (7), the US-EPA document Guidance of Choosing a Sampling Design for Environmental Data Collection (8) and Statistical Methods for Environmental Pollution Monitoring by Richard O. Gilbert (5).

5.3.6 Authoritative Sampling

Authoritative sampling is based on the judgement of the investigator, and does not necessarily result in a sample that reflects the average characteristics of the entire matrix. There are two types of authoritative designs: judgmental sampling and biased sampling. Judgmental sampling uses the knowledge and experience of the investigator to attempt to derive "average" conditions at a site. In contrast, biased sampling attempts to determine the maximum or minimum value for contaminant of concern. Biased sampling often focuses on "worst case" conditions in a matrix, for example, the most visually contaminated area or the most recently generated waste.

The primary advantages of authoritative sampling are the designs tend to be quick and simple to implement, and the designs have relatively low costs. Authoritative sampling is ideally suited for sites where contaminants of concern greatly exceed, or are significantly below, predetermined action levels. Because the experience of the investigator is often the basis for sample collection, personal bias (depending on the study objectives) may be introduced and should be recognized as a potential problem. However, preliminary or screening investigations, and certain regulatory investigations, will correctly employ authoritative sampling.

5.3.7 Simple Random Sampling

Simple random sampling insures that each element in the population has an equal chance of being included in the sample. This is often be the method of choice when, for purposes of the investigation, the matrix is considered homogeneous or when the population is randomly heterogeneous. If the population contains trends or patterns of contamination, a stratified random sampling or systematic grid sampling strategy would be more appropriate.

5.3.8 Systematic Sampling over Time or Space

Systematic sampling over time at the point of generation is useful if the material was sampled from a wastewater sewer, a materials conveyor belt, or being delivered via truck or pipeline. The sampling interval would be determined on a time basis, for example every hour from a conveyor belt or pipeline discharge, or from every third truck load. Systematic sampling over space might involve the collection of samples at defined intervals from a ditch, stream, or other matrix that is spatially unique.

5.3.9 Stratified Random Sampling

Stratified random sampling may be useful when distinct strata or "homogeneous sub-groups" are identified within the population. The strata could be located in different areas of the population, or the strata may be comprised of different layers. This approach is useful when the individual strata may be considered internally homogeneous, or at least have less internal variation, in what would otherwise be considered a heterogeneous population. Information on the site is usually required to establish the location of individual strata. A grid may be utilized for sampling several horizontal layers if the strata are horizontally oriented. A simple random sampling approach is typically utilized for sample collection within each strata. The use of a stratified random sampling strategy may result in the collection of fewer samples.

5.3.10 Systematic Grid Sampling

Systematic grid sampling involves the collection of samples at fixed intervals when the contamination is assumed to be randomly distributed. This method is commonly used with populations when estimating trends or patterns of contamination. This approach may not be acceptable if the entire population is not accessible, or if the systematic plan becomes "phased" with variations in the distribution of contaminants within the matrix. This approach may also be useful for identifying the presence of strata within the population. The grid and starting points should be randomly laid out over the site, yet the method allows for rather easy location of exact sample locations within each grid. Also, the grid size would typically be adjusted according to the number of samples that are required.

5.3.11 Adaptive Cluster Sampling

Adaptive sampling designs are ones in which additional decisions units or sample locations are selected depending on the interpretation of measurements or observations made during an initial survey (8). Additional sample locations are selected when a contaminant of concern in one or more units exceeds some predetermined action level in the initial survey. Adaptive cluster sampling is a beneficial design for sites where a contaminant of concern is sparsely distributed but highly concentrated. Simple random or systematic grid sampling can be used in conjunction with adaptive cluster sampling designs.

5.4 General Considerations for Sampling Designs

Prior to commencing work on any project, the objective of the study in terms of the purpose the data generated is to serve should be known. Some examples of uses for which data are generated include:

- RCRA waste identification investigations;
- RCRA or Superfund screening investigations (presence or absence of contaminants);
- Superfund Remedial Investigations, Removal Actions, or Feasibility Studies;
- Surface water and sediment studies;
- Wastewater treatment plant evaluations;
- Monitoring investigations;
- UST/UIC investigations; and
- Special environmental characterization investigations.

The purpose of data collection is to meet the objectives of the investigation. The process of designing an investigation typically follows a logical series of steps. Proper evaluation of these steps will greatly enhance the project leader's ability to choose a design which adequately serves the purpose of the study. The DQO process may not be strictly followed, but the elements of the process are always considered during study planning. These elements include:

- State the environmental problem;
- Collection of information concerning historical data, site survey, and site history;
- Identification of the decision to be made with the data collected;
- Identification of data gaps;
- Identification of objectives, and investigation boundaries;
- Sampling design selection and design optimization;
- Sample types and number;
- Analytical requirements and limitations; and
- Data interpretation and assessment.

5.5 Soil Sampling Designs

The objectives of a soil sampling investigation must be clearly defined in terms of the purpose of the data generated. A discussion of study planning elements that include considerations specific to soil investigations follows.

5.5.1 Historical Sampling Data, Site Survey, and Site History

Investigations that are used for initial site screening purposes are one of the few cases where historical sampling data is usually not available. In this case, the purpose of the sampling effort is to determine the presence/absence of contaminants and if present, to determine their nature. Such a purpose can be served with a minimum of samples whose locations can be determined from a site survey and a review of the site history. When designing a soil sampling study for purposes other than site screening, a record of previous sampling efforts is usually available from which a relatively sound foundation of historical sampling data can be derived.

The site survey is invaluable for soil sample design. Information which should be obtained during a site survey includes:

- General site layout;
- Site access;
- Soil types and depths;
- Surface water drainage pathways;
- Existing site conditions;
- Visible staining of surface soil;
- Vegetation stress; and
- Possible offsite or non-site related sources.

The site history should include factors such as previous land use both on and nearby the site, types of industrial operations conducted both on the site and on adjoining property, types of contaminants to which the site has been exposed, and locations of possible dumping/burial areas. The site history can be derived from property plats, tax records, aerial photos, and interviews with people familiar with the site.

5.5.2 Data Quality Objectives (DQOs)

Consideration of the purpose which the data generated from the soil sampling effort is to serve drives the selection of DQOs. DQO selection will then be the main factor which determines the types of samples to be collected, the types of equipment to be used, and the analytical requirements for the samples. See Section 5.12 for a discussion of DQOs.

5.5.3 Authoritative Designs for Soil Investigations

When the purpose of the investigation is to determine the presence of contaminants, a simple strategy can be used. Such a purpose is normally encountered during screening inspections, criminal investigations, and any other project where the scope is limited to gathering evidence of contamination. These cases are normally characterized by a lack of previous sampling data, thereby requiring that sample types and locations be determined by site history and a site survey. In these instances, an authoritative design is normally used.

Authoritative sampling usually involves a limited number of locations (10 to 15) from which grab samples are collected. Locations are selected where there is a good probability of finding high levels of contamination. Examples may include areas where significant releases or spillage occurred according to the site history or areas of visible staining, stressed vegetation, or surface drainage are noted in the site survey. An authoritative design usually involves the selection of two or three control sampling locations to measure possible contaminants migrating onto the site from adjacent sources not involved in the study. The selection of control locations is similar to the selection of other sampling locations, except that upstream or upgradient control samples are expected to be unaffected by site contaminants.

Because of the biased nature of an authoritative design, the degree of representativeness is difficult to estimate. Authoritative samples are not intended to reflect the average characteristics of the site. Since determining representativeness is not an issue with this type of design, duplicate samples designed to estimate variability are not normally collected. However, split samples should be collected to measure sample handling variability.

An interactive approach may be used in an authoritative design to determine the extent of contamination on a site when the source can be identified. Samples are typically collected using a pattern that radiates outward from the source. The direction of contaminant migration may not be known which will result in the collection of more samples, and in this case field screening would be desirable to help in determining appropriate sampling locations.

5.5.4 Systematic Grid Sampling Designs for Soil Investigations

In cases where both the presence of contaminants and the extent of contamination needs to be determined, an authoritative design is inappropriate as site variability cannot be estimated without collecting an inordinate number of samples. A systematic design is normally used during investigations when determining the extent of contamination, such as remedial investigations and removal actions.

Once a site has reached the stage where the extent of contamination becomes an issue, access to data from previous sampling efforts (screening investigations) which used an authoritative design is normally available. The preliminary data can be used to estimate the variability of contaminant concentrations as a function of area and/or depth for purposes of planning the more extensive systematic design. In the absence of previous sampling data a variability study should be conducted. An alternative would be to estimate the variability, with confirmation of the estimate being made during the more extensive systematic study. If a variability study is to be conducted, it will be limited in scope and will use certain default values or assumptions to determine the number of samples to collect for determining site variability. The methods used for variability studies are included in the following discussion of systematic sampling strategies.

<u>Determination of the Number of Samples to Collect</u>

When designing a systematic grid sampling investigation, the number of samples to be collected must be determined first. This can be calculated based on variability information derived from previous sampling data. Upon review of the historical data, a contaminant or contaminants of concern (COCs) can be selected. COCs are parameters which are closest to or in excess of an action level. Their presence is normally the driving force behind the need to determine the extent of contamination.

The following steps are to be followed to determine the number of samples to collect (6):

1. Select a margin of error (p) acceptable for the subsequent use of the data. For soil studies, a margin of error of 0.20 is not unusual. The margin of error may be obtained by dividing the precision wanted (in units of concentration; e.g. ±10 ppm, etc.) by the known or anticipated mean concentration of the COCs. Note that changes in the precision or mean concentration for the COC relative to those anticipated during the planning process may require a re-evaluation of the assumed margin of error.

2. A coefficient of variation (CV), which is defined as the standard deviation of a COC divided by the mean of the COC, is either obtained using previous sampling data, or estimated based on anticipated variability. If a CV above 0.65 is obtained, a large number of samples will usually result.

   The number of samples required may be minimized by using a stratified design if areas with known high variability can be identified and addressed separately from areas of lower variability. Areas of high variability will require more samples while areas of low variability will require fewer using the approach outlined in this section. The overall effect will normally be a substantially lower number of samples for the entire site.

3. A confidence level (t_α) needs to be established. For work involving hazardous wastes, a confidence level of 95% should be used. For a 95% confidence level, a factor of 1.96 (from standard statistical tables) is used to calculate the number of samples required.

4. The required number of samples is calculated using the following formula:

$$n = \frac{t_\alpha^2 (CV)^2}{p^2}$$

   Where:

n	= number of samples to collect
t_α	= statistical factor for a 95% confidence level
CV	= coefficient of variation
p	= margin or error

   In a case where no previous sampling data is available, the default values given in the previous discussion can be used.

$$n = \frac{(1.96)^2 (0.65)^2}{(0.20)^2}$$

$$n = 40 \text{ samples}$$

Upon completion of the soil sampling effort, the data obtained for the COCs is reviewed. It can then be determined if an adequate number of samples were collected with respect to the margin of error and confidence selected during the planning process. This determination is completed by calculating the CV using the data obtained during the study. The standard deviation of the concentration for a COC is divided by the mean concentration and the CV is calculated. This CV may be higher or lower than the CV selected during the planning process. Using this CV value, the same equation is used to determine the required number of samples based on the actual CV for the study. If this second value for "n" is less than or equal to the number of samples collected during the study, then the site has been characterized for the extent of COCs within the limits of confidence and error stated. If the second value for "n" is significantly greater, then additional sampling is necessary, or an adjustment to the margin of error or confidence level should be considered. If the collection of additional samples is deemed necessary by the investigation team, the data that has been generated may be used to plan for a more efficient and cost-effective re-sampling of the site. Areas of the site where higher than anticipated variabilities were obtained may be segregated from areas of lower variability (stratified design). A recalculation of the number of samples required to characterize each strata should then be completed and resampling may proceed.

The following table illustrates the number of samples required at a 95% confidence level with varying margins of error (p) and coefficients of variation (CV):

	Coefficient of Variation (CV)				
	0.1	0.5	0.65	1.0	2.0
Margin of Error (p)					
0.1	4	96	162	384	1537
0.2	1	24	**40**	96	384
0.3	-	10	18	42	170
0.5	-	4	6	15	61
1.0	-	1	2	4	15
2.0	-	-	-	1	4
	Number of Samples (n)				

Note that as the CV increases at a set margin of error, the number of samples required increases. When the variability is low (as measured by the standard deviation or the square root of the variance) relative to the mean of the data, then the CV is low. However, as the variability in the population begins to increase relative to the mean of the data, then the CV increases and the number of samples required increases if characterization of the site at a 95% confidence level and a set margin of error is desired.

A similar relationship is observed for the margin of error. When the precision required (say $\pm$ 10 ppm lead) is high relative to the mean of the data (say 100 ppm lead), then the margin of error is low (in this case 0.1). In this case 162 samples would be required with a CV of 0.65. If the investigators could accept a higher margin of error (e.g., ± 20%), and the mean concentration of the data is still 100 ppm lead, then the resulting margin of error (0.2) would result in a lower number of required samples. Note that 40 samples would be required at the same CV of 0.65.

If the investigators change the confidence level, then the numbers in the table provided would change accordingly. If the confidence level is decreased to 80%, then the required number of samples reflected in this table would be lower for each margin of error and CV combination.

Establishment of the Grid

Having determined the number of samples to collect, the project leader should then determine how to disperse the samples within the site. Commonly, a grid system is used. The number of grids is equal to the number of samples required for a systematic grid design. Grids may also be used to determine sampling locations when using a random design; however, with this type of design every grid is not sampled.

The size of the grids is calculated by dividing the area of the site by the number of samples required. The product of this calculation is the area of each grid. By taking the square root of the grid area, the length of a grid side is determined.

$$G = (a/n)^{1/2}$$

Where:

G	= length per side of each individual grid
a	= area
n	= number of samples required

The length of a grid size should be "rounded" down to some number convenient for the method used in laying out the grid (e.g., plane survey, geographical positioning system (GPS), etc.). Rounding down the grid size will increase the number of samples slightly. It is important to remember that the number of samples calculated is the minimum, and that site conditions may not allow for collection of all samples. Therefore, additional samples would be appropriate.

Grab vs Composite Samples

When designing a systematic grid sampling investigation, a determination of whether to collect grab or composite samples must be made. Grab samples may not adequately describe variability, even within individual grid cells, and therefore, limit the representativeness of the data set. If the study involves a small area with grid cells of 25 feet or less in length, then grab samples could be collected in each grid cell without significantly affecting the representativeness of the data. However, most studies have much larger grids (100 to 500 feet per side). In these cases, composite samples collected within each grid cell result in more representative data. It should be remembered that a composite sample under the best of conditions will yield an average value of contaminants within the grid. Composite samples are most appropriate where a reasonable degree of variability is anticipated, and where soil types are amenable to adequate mixing. This is normally the case when contaminants have been distributed by airborne deposition (relatively homogeneous distribution across the site). Where localized "hot spots" are present due to releases from process units, indiscriminate dumping, or the burying of wastes, a more specialized approach that takes these types of distribution into account is required. Situations where the distribution of contaminants is strongly non-random (heterogeneous distributions) are the most difficult to plan for and characterize.

Composite samples should consist of five to nine aliquots per sample located on compass points within the grid cell. Greater than nine aliquots per sample can result in dilution of fairly high concentrations down to a value below the analytical detection limits. Less than 5 aliquots may limit the representativeness of the sample with no added value over a single grab sample within the grid cell. A certain number of samples are collected (10 percent of the grid cells is often selected) during the investigation for variability determinations based on rotating the aliquot distribution pattern on the points of the compass within the grid cell.

Surface vs Sub-Surface Samples

The two main considerations for sub-surface soil samples are contaminant mobility and type of deposition. A contaminant that is relatively immobile in soil will naturally be found in the same area in which it was deposited. Mobile contaminants require specialized consideration of the likely extent of their migration in order to determine sub-surface soil sampling locations and depths. Airborne deposition of mobile contaminants normally require a considerable amount of sub-surface soil sampling to determine their extent in a systematic design.

5.6 Ground Water Sampling Designs

Sampling design, as it pertains to ground water, often involves the use of some form of temporary well point or direct push technology (DPT) for rapid in-field screening and plume delineation. These techniques are discussed in Section 6. Samples obtained using these techniques are usually analyzed immediately, using an on-site field laboratory, or are sent to an off-site laboratory for quick turnaround analyses. In this manner, delineations of both a horizontal (areal) and vertical nature can be rapidly achieved in the field. These delineations can then be used as the basis for locating and installing permanent ground water monitoring wells.

The degree of complexity for these delineations varies, depending on a number of factors which include:

- The known or anticipated size of the suspected source area.
- Site stratigraphy.
- The amount of information regarding hydrogeological conditions (thickness of aquifers or water-bearing units, depth to confining units, ground water flow direction, etc.).
- The type of contamination (aqueous phase, light non-aqueous phase liquid (LNAPL), or dense non-aqueous phase liquid (DNAPL)).

In addition to the design considerations imposed by the preceding factors, screening program designs may be either simple iterative or grid-based. Grid-based may even transform, at some point, to a more or less iterative program.

5.6.1 Single Source Iterative Programs

The simplest case is one in which there is a small source area of an aqueous phase contaminant or component, such as benzene, toluene, ethyl benzene, and xylene (BTEX) contamination without associated product, and there is a high degree of confidence with respect to ground water flow direction. In this situation, a sample location would be placed in the middle of the source area, for source area characterization, and several locations would be established downgradient. It is not possible to specify the numbers and locations for these sampling points. Three points would typically be the minimum number, one located immediately downgradient of the source area and two located to either side of the center line. If contaminants were detected in any of the downgradient locations, additional locations would need to be established downgradient and/or side-gradient of those locations to complete boundary delineation. This process would continue until both the downgradient and lateral extent of the contamination were established.

As indicated, the numbers and locations of these sampling locations are subject to site scale and other factors and can only be determined in the field using best judgement. At this point, some attention should be given to vertical characterization of the contaminants. Additional samples should be collected at locations below the depths at which the contaminants were identified until the vertical extent is determined. If this is not accomplished during screening activities, it must be done during subsequent investigations with permanent monitoring wells.

Single-source light non-aqueous phase liquids (LNAPL) problems are generally no more complicated than the non-aqueous phase delineation problems. If there are no serious vertical profiling problems, however, the sampling device should be capable of identifying the presence of and determining the thicknesses of the floating LNAPL layers.

A more complex situation would be a single source area in which there is a dense non-aqueous phase liquid (DNAPL) product layer with associated aqueous phase contamination. The initial part of the investigation would be conducted in a manner similar to the simplest case. After delineation of the aqueous phase plume, additional characterization would be required for the DNAPL component. If a confining layer is present and the depth to the surface of this layer is known, samples should be collected from the boundary between the water-bearing formation and the confining unit to determine if DNAPL products are present. Wherever DNAPLs are found, additional samples must be collected. The rationale for sample location selection depends on both sub-surface structure and ground water flow direction. DNAPL constituents may flow down-dip on the surface of confining units, in directions that are totally contrary to ground water flow directions. No attempt at DNAPL characterization should be made until the site geology (stratigraphy, structure and ground water flow patterns) are known.

5.6.2 Multiple-Source Area Grided Programs

Some ground water screening investigations involve identifying multiple source areas and determining the size and shape (delineation) of the associated plumes over relatively large areas. In these cases, it may be appropriate to pre-determine and establish a grid pattern to direct the collection of ground water samples. As the apparent contaminant pattern begins to develop, it may be appropriate to disregard established but unsampled sampling locations and concentrate on other areas within the grid pattern. It may even be appropriate to expand the area of investigation by establishing additional sampling locations. These locations may be determined by using a grid or may be located using best judgement, in an iterative manner.

Considerations regarding non-aqueous phases must be observed here as well. If aqueous phase sample analysis indicates that DNAPL constituents may be present, sampling should be conducted at the surface of the confining unit to determine if product layers are present.

5.6.3 Typical Ground Water Screening Devices

Listed below are numerous tools, devices, and techniques available to field investigators that can be used to effectively collect ground water samples for rapid field screening and plume delineation.

- Temporary wells -- Well casing can be installed temporarily, either inside hollow-stem augers or in an open hole after removal of hollow- or solid-stem augers. Because of the potential for cross-communication between vertical intervals, this technique is appropriate only for screening the upper portion of the saturated zone. Samples are pumped or bailed directly from the well casing. Because turbidity is likely to be a problem using this technique, care should be taken when using the samples for metals screening. Depth of the investigation is limited only by the capability of the drill rig and cross-contamination considerations. See section 6.10 for temporary well installation procedures.

- Geoprobe® -- Slotted steel pipe is hydraulically pushed or hammer driven to the desired sampling depth. Samples are usually acquired with a peristaltic pump. The device is subject to cross-communication at threaded rod joints. It requires some knowledge of the saturated interval. The Geoprobe® is most useful at depths less than 30 to 40 feet below ground surface.

- Hydropunch® -- A larger, more versatile device, similar to the Geoprobe®, which is pushed to sampling depths with a drill rig. It requires some knowledge of saturated intervals to use successfully. Depths of investigation with this technology are roughly correlated to the capability of the drill rig used to push the sampling device.

- Hydrocone® -- This is a pressure-sealed sampling device that is hydraulically pushed to the desired sampling depth. It is capable of collecting a discrete sample from any depth at which it can be pushed. A limited volume of about 700 ml is collected and is generally turbid. This technique is mainly applicable for the screening for volatile organic compounds. A temporary well point can be driven by the same drill rig to collect samples with greater volume requirements. Samples from depths exceeding 100 feet have been obtained with this device. Routine depths obtained without special anchoring are generally within the 50-foot range, but are dependent on the geological materials being encountered.

5.7 Surface Water and Sediment Sampling Designs

5.7.1 Sampling Site Selection

The following factors should be considered in the selection of surface water and sediment sampling locations:

- Study objectives;
- Water use;
- Point source discharges;
- Nonpoint source discharges;
- Tributary locations;
- Changes in stream characteristics;
- Type of stream bed;
- Depth of stream;
- Turbulence;
- Presence of structures (weirs, dams, etc.);
- Accessibility; and
- Tidal effect (estuarine).

If the study objective is to investigate a specific water use such as a source of water supply, recreation, or other discrete use, then considerations such as accessibility, flow, velocity, physical characteristics, etc., are not critical from a water quality investigation standpoint.

If the objective of a water quality study is to determine patterns of pollution, provide data for mathematical modeling purposes, conduct assimilative capacity studies, etc., where more than a small area or short stream reach is to be investigated, then several factors become interrelated and need to be considered in sampling location selection. An excellent reference guide to conducting surface water stream studies is F. W. Kittrells, "A Practical Guide to Water Quality Studies" (9).

Before any sampling is conducted, an initial reconnaissance should be made to locate suitable sampling locations. Bridges and piers are normally good choices as sampling sites since they provide ready access and permit water sampling at any point across the width of the water body. However, these structures may alter the nature of water flow and thus influence sediment deposition or scouring. Additionally, bridges and piers are not always located in desirable locations with reference to waste sources, tributaries, etc. Wading for water samples in lakes, ponds, and slow-moving rivers and streams must be done with caution since bottom deposits are easily disturbed, thereby resulting in increased sediments in the overlying water column. On the other hand, wadeable areas may be best for sediment sampling. In slow-moving or deep water, a boat is usually required for sampling. Sampling station locations can be chosen without regard to other means of access if the stream is navigable by boat, especially in estuarine systems where boats frequently provide the only access to critical sampling locations.

Fresh water environments are commonly separated into two types:

- Flowing water, including rivers, creeks, and small to intermittent streams; and
- Water that is contained, with restricted flow including lakes, ponds, and manmade impoundments

Since these waterways differ considerably in general characteristics, site selection must be adapted to each. Estuarine environments are a special case and are discussed separately.

5.7.2 Rivers, Streams, and Creeks

In the selection of a surface water sampling site in rivers, streams, or creeks, areas that exhibit the greatest degree of cross-sectional homogeneity should be located. When available, previously collected data may indicate if potential sampling locations are well mixed or vertically or horizontally stratified. Since mixing is principally governed by turbulence and water velocity, the selection of a site immediately downstream of a riffle area will insure good vertical mixing. These locations are also likely areas for deposition of sediments since the greatest deposition occurs where stream velocities decrease provided that the distance is far enough downstream from the riffle area for the water to become quiescent. Horizontal (cross-channel) mixing occurs in constrictions in the channel, but because of velocity increases, the stream bottom may be scoured, and therefore, a constriction is a poor location to collect sediment.

Typical sediment depositional areas are located:

- Inside of river bends;
- Downstream from islands;
- Downstream from obstructions; and
- Areas of flow reversals, such as back-shoots.

Sites that are located immediately upstream or downstream from the confluence of two streams or rivers should generally be avoided since flows from two tributaries may not immediately mix, and at times due to possible backflow can upset the depositional flow patterns.

When several locations along a stream reach are to be sampled, they should be strategically located:

- At intervals based on time-of-water-travel, not distance, e.g., sampling stations may be located about one-half day time-of-water-travel for the first three days downstream of a waste source (the first six stations) and then approximately one day through the remaining distance.

- At the same locations if possible, when the data collected is to be compared to a previous study.

- Whenever a marked physical change occurs in the stream channel. Example: A stream reach between two adjacent stations should not include both a long rapids section of swift shallow water with a rocky bottom, and a long section of deep, slow-moving water with a muddy bottom. Stations at each end of the combined reach would yield data on certain rates of change, such as reaeration, that would be an unrealistic average of two widely different rates. The actual natural characteristics of the stream would be better defined by inserting a third sampling station within the reach, between the rapids and the quiet water sections.

- To isolate major discharges as well as major tributaries. Dams and weirs cause changes in the physical characteristics of a stream. They usually create quiet, deep pools in river reaches that previously were swift and shallow. Such impoundments should be bracketed with sampling stations. When time-of-water-travel through the pools are long, stations should be established within the impoundments.

Some structures, such as dams, permit overflow and cause swirls in streams that accomplishes significant reaeration of oxygen deficient water. In such cases, stations should be located short distances upstream and downstream from the structures to measure the rapid, artificial increase in dissolved oxygen, which is not representative of natural reaeration.

When major changes occur in a stream reach, an upstream station, a downstream station, and an intermediate station should be selected. Major changes may consist of:

- A wastewater discharge;
- A tributary inflow;
- Non-point source discharge (farms or industrial sites); and
- A significant difference in channel characteristics.

The use of three stations is especially important when rates of change of unstable constituents are being determined. If results from one of only two stations in a subreach are in error for some unforeseen reason, it may not be possible to judge which of the two sets of results indicate the actual rate of change. Results from at least two of three stations, on the other hand, may support each other and indicate the true pattern of water quality in the subreach.

To determine the effects of certain discharges or tributary streams on ambient water quality, stations should be located both upstream and downstream from the discharges. In addition to the upstream and downstream stations bracketing a tributary, a station should be established on the tributary at a location upstream and out of the influence of the receiving stream.

Unless a stream is extremely turbulent, it is nearly impossible to measure the effect of a waste discharge or tributary immediately downstream from the source. Inflow frequently "hugs" the stream bank due to differences in density, temperature, and specific gravity, and consequently lateral (cross-channel) mixing does not occur for some distance.

Tributaries should be sampled as near the mouth as feasible. Frequently, the mouths of tributaries are accessible by boat. Care should be exercised to avoid collecting water samples from stratified locations which are due to differences in density resulting from temperature, dissolved solids, or turbidity.

Actual sampling locations will vary with the size of the water body and the mixing characteristics of the stream or river. Generally, for small streams less than 20 feet wide, a sampling site should be selected where the water is well mixed. In such cases, a single grab sample taken at mid-depth at the center of the channel is adequate to represent the entire cross-section. A sediment sample could also be collected in the same vicinity if available.

For slightly larger streams, at least one vertical composite should be collected from mid-stream. Samples should be collected just below the surface, at mid-depth, and just above the bottom. For larger streams and rivers, at least quarter point (1/4, 1/2, and 3/4 width) composite samples should be collected. Dissolved oxygen, pH, temperature, and conductivity should be measured from each aliquot of the vertical composite.

For large rivers, several locations across the channel width should be sampled. Vertical composites across the channel width should be located in a manner that is roughly proportional to flow, i.e., they should be closer together toward mid-channel, where most of the flow is, than toward the banks, where the proportion of total flow is less. The number of vertical composites required and the number of depths sampled for each are usually determined in the field by the investigators. This determination is based on a reasonable balance between the following two considerations:

- The larger the number of subsamples, the more closely the composite sample will represent the water body; and

- Subsample collection is time-consuming and expensive, and increases the chance of cross-contamination.

In most circumstances, a number of sediment samples should be collected along a cross-section of a river or stream in order to adequately characterize the bed material. A common procedure is to sample at quarter points along the cross-section. When the sampling technique or equipment requires that the samples be extruded or transferred on site, they may be combined into a single composite sample. However, samples of dissimilar composition should not be combined but should be stored for separate analysis in the laboratory. Often, sediment must be collected in back-shoots or areas on the inside of bends in the stream due to scouring in the main channel. To insure representative samples, the preferred method is diver deployed coring tubes.

5.7.3 Lakes, Ponds, and Impoundments

Lakes, ponds, and impoundments have a much greater tendency to stratify than rivers and streams. The relative lack of mixing generally requires that more samples be obtained. Occasionally, an extreme turbidity difference may occur where a highly turbid river enters a lake. For these situations, each layer of the vertically stratified water column needs to be considered. Since the stratification is caused by water temperature differences, the cooler, more dense river water is beneath the warmer lake water. A temperature profile of the water column as well as visual observation of lake samples can often detect the different layers which can be sampled separately.

The number of water sampling stations on a lake, pond, or impoundment will vary with the objective of the investigation as well as the size and shape of the basin. In ponds and small impoundments, a single vertical composite at the deepest point may be sufficient. Dissolved oxygen, pH, and temperature are generally measured for each vertical composite aliquot. In naturally-formed ponds, the deepest point is usually near the center; in impoundments, the deepest point is usually near the dam.

In lakes and larger impoundments, several vertical subsamples should be composited to form a single sample. These vertical sampling locations are often collected along a transect or grid. The number of vertical subsamples and the depths at which subsamples are taken are usually at the discretion of the field investigators. In some cases, it may be of interest to collect separate composites of epilimnetic and hypolimnetic zones (above and below the thermocline or depth of greatest temperature change).

In lakes with irregular shapes and with several bays and coves that are protected from the wind, additional separate composite samples may be needed to adequately determine water quality. Similarly, additional samples should be collected where discharges, tributaries, land use characteristics, etc., are suspected of influencing water quality.

When collecting sediment samples in lakes, ponds, and reservoirs, the sampling site should be approximately at the center of the water mass. This is particularly true for reservoirs that are formed by the impoundment of rivers or streams. Generally, the coarser grained sediments are deposited near the headwaters of the reservoir, and the bed sediments near the center of the water mass will be composed of fine-grained materials. The shape, inflow pattern, bathymetry, and circulation must be considered when selecting sediment sampling sites in lakes or reservoirs.

5.7.4 Estuarine Waters

Estuarine areas are zones where inland freshwaters (both surface and ground) mix with oceanic saline waters. Estuaries are generally categorized into three types, dependent upon freshwater inflow and mixing properties:

- Mixed estuary -- Characterized by an absence of vertical halocline (gradual or no marked increase in salinity in the water column) and a gradual increase in salinity seaward. Typically this type of estuary is found in major freshwater sheetflow areas, featuring shallow depths.

- Salt wedge estuary -- Characterized by a sharp vertical increase in salinity and channelized freshwater inflow into a deep estuary. In these estuaries, the vertical mixing forces cannot override the density differential between fresh and saline waters. In effect, a salt wedge tapering inland moves horizontally, back and forth, with the tidal phase.

- Oceanic estuary -- Characterized by salinities approaching full strength oceanic waters. Seasonally, freshwater inflow is small with the preponderance of the fresh and saline water mixing occurring near, or at, the shore line.

A reconnaissance investigation should be conducted for each estuarine study unless prior knowledge of the estuarine type is available. The reconnaissance should focus upon the freshwater and oceanic water dynamics with respect to the study objective. National Oceanic Atmospheric Administration (NOAA) tide tables and United States Geological Survey (USGS) freshwater surface water flow records provide valuable insights into the estuary hydrodynamics. The basic in-situ measurement tools for reconnaissance are:

- Boat;
- Recording fathometer;
- Salinometer;
- Dissolved oxygen meter; and
- Global Positioning System (GPS) equipment and charts.

These instruments coupled with the study objective or pollution source location, whether it is a point or non-point source problem, provide the focus for selecting sampling locations. More often than not, preplanned sampling locations in estuarine areas are changed during the actual study period. Because of the dynamics of estuaries, the initial sampling results often reveal that the study objective could be better served by relocating, adding, or deleting sampling locations.

Water sampling in estuarine areas is normally based upon the tidal phases, with samples collected on successive slack tides. All estuarine sampling should include vertical salinity measurements at one to five-foot increments coupled with vertical dissolved oxygen and temperature profiles. A variety of water sampling devices are used, but in general, the Van Dorn (or similar type) horizontal sampler or peristaltic pump are suitable.

Samples are normally collected at mid-depth in areas where the depths are less than 10 feet, unless the salinity profile indicates the presence of a halocline (salinity stratification). In that case, samples are collected from each stratum. Depending upon the study objective, when depths are greater than 10 feet, water samples may be collected at the one-foot depth from the surface, mid-depth, and one-foot from the bottom.

Generally, estuarine investigations are two phased, with study investigations conducted during wet and dry periods. Depending upon the freshwater inflow sources, estuarine water quality dynamics cannot normally be determined by a single season study.

5.7.5 Control Stations

In order to have a basis of comparison of water quality, the collection of samples from control stations is always necessary. A control station upstream from the waste source is as important as are stations downgradient, and should be chosen with equal care to ensure representative results. In some situations it is desirable to have background stations located in similar, nearby estuaries which are not impacted by the phenomena or pollutants being investigated. At times it may be desirable to locate two or three stations downstream from the waste inflow to establish the rate at which the unstable material is changing. The time-of-water-travel between the stations should be sufficient to permit accurate measurement of the change in the constituent under consideration.

5.8 Waste Sampling Designs

5.8.1 Introduction

Waste sampling involves the collection of materials that are typically generated from industrial processes, and therefore may contain elevated concentrations of hazardous constituents. Waste sampling in its broadest term is conventionally considered to be sampling of processed wastes or man-made waste materials. Because of the regulatory, safety, and analytical considerations, wastewater sampling should be separate from waste sampling. Environmental sampling is also different from waste sampling as it involves the collection of samples from natural matrices such as soil, sediment, groundwater, surface water, and air.

It is convenient to distinguish waste management units into two types due to Branch safety protocols. The first, "open units", are units where wastes are generated, stored, or disposed, and would be open to the environment and environmental influences. Examples of open waste units are surface impoundments and waste piles. "Closed units" are waste containers/drums, tanks, or sumps where the potential for the accumulation of toxic vapors or explosive/ignitable gases exists. While both open and closed waste units are considered dangerous because of the potential exposure to concentrated hazardous constituents, closed units are regarded as high hazards due to their potential to accumulate gases and vapors.

5.8.2 Waste Investigation Objectives

Systematic planning is critical for identifying a study's objectives and conducting a successful investigation. Thorough understanding of the waste generation/management practices is required for the samples and associated data to reflect the waste population characteristic(s) of interest. Prior to sampling wastes, it is extremely important to obtain and assess all of the available information, e.g., waste generation process(es), waste handling and storage practices, previous field screening results, existing sampling and analytical data, any pertinent regulations, and permitting or compliance issues.

Common objectives in waste sampling investigations include:

- to determine if a constituent is present in a waste,
- to determine if a waste exhibits a property or characteristic,
- to determine if a material is a hazardous waste,
- to characterize a wastestream, and
- to determine if a waste material has been released into the environment.

The most frequently used objective during RCRA Case Development/Investigation Evaluations and Criminal Field Investigations involve hazardous waste determinations. For studies that are designed to determine if a release has occurred, it is recommended that samples be collected from the source as well as both the affected and the unaffected media.

Waste matrices are frequently heterogenous in nature due to the physical characteristics of the material (particle size, viscosity, etc.), the distribution of hazardous constituents within the matrix, or the manner in which the material has been managed or disposed. When waste is comprised of strata that can be separated by the sampling equipment (e.g., liquid-liquid or liquid-solid phases), it is not necessary to collect a sample that is representative of the entire unit to make a waste determination. An acceptable objective would be to make a waste determination on a specific strata. For example in drums containing a liquid phase on top of solids, a glass thief or a COmposite LIquid WAste SAmpler (COLIWASA) could be used to sample only the liquid to determine if the phase of interest exhibits the characteristic of ignitability as described in 40 CFR, Part 261.21.

5.8.3 Considerations for Waste Sampling Designs

Waste sampling designs should consider the variability of the sample population in terms of the characteristic of concern, the physical size and state of items present in the population, and the ability to access all portions of the population for purposes of sampling. Elements of the sampling design should include the determination of the sample locations and the number of samples to be collected, decisions on the type of samples (grab or composite) to collect, and selection of the appropriate sampling equipment. While sample locations are usually restricted to accessible portions of a waste unit's population, the number of samples to be collected is usually determined by the objective of the study. Factors to consider when determining the appropriate number of samples are; preliminary information on the waste, the size of the sample population, field screening results, the variability of the waste, and the budget for the investigation. Composite samples are used to obtain average concentrations of waste units while grab samples are utilized to delineate hot spots or to acquire data for sample variability, or to determine compliance with Land Disposal Restrictions (LDR) treatment standards.

A small wastestream that has a hazardous constituent or characteristic randomly distributed in a relatively homogeneous matrix requires fewer samples than a large wastestream that has a constituent or characteristic of concern which is non-randomly distributed in a heterogeneous matrix. For a waste with constituent of concern that is randomly distributed, an authoritative or systematic grid sampling design would be appropriate depending on the objectives. On the other-hand, a stratified sampling or very specialized design should be employed for wastes that are non-randomly distributed.

Reviewing the available preliminary information should improve the effectiveness of any sampling investigation. If waste variability cannot be estimated after review of available information, then a preliminary sampling and analytical effort may be necessary. A preliminary sampling investigation would be important when the study's objective is to fully characterize a waste stream using a probabilistic or "statistical" design.

Probabilistic sampling designs similar to the ones used to characterize a site with soil contamination can be used to characterize large units such as waste piles or surface impoundments with random contaminant distributions. Note that an authoritative design is often appropriate to demonstrate the maximum degree of contamination in certain waste management units. Examples include the collection of a sludge sample for inorganic analyses at the inlet to a surface impoundment, or a sample for volatile organic compound analysis collected from the most recently generated material placed in a waste pile.

A comprehensive probabilistic design may be required to fully characterize unusually complex wastestreams that have a high degree of heterogeneity. For some highly complex, heterogeneous wastes where an average concentration would not be reflected by a design of reasonable scope, an authoritative sampling design based on the sampler's experience may be the only feasible approach. For a heterogeneous waste population, it may be necessary to segregate and sample components suspected of containing constituents of concern.

Background samples are <u>not</u> required when collecting highly concentrated waste samples.

5.8.4 Waste Sampling Equipment

An extremely important factor in the sampling strategy will be determined by the physical characteristics of the waste material. Selecting appropriate sampling equipment can be one of the most challenging tasks while planning a sampling investigation. By selecting sampling equipment that will not discriminate against certain physical characteristics (e.g., phase, particle size, etc.), sampling bias can be minimized during waste sampling. Because wastes often stratify due to different densities of phases, settling of solids, or varying waste constituents generated at different times, it also may be important to obtain a vertical cross section of the entire unit.

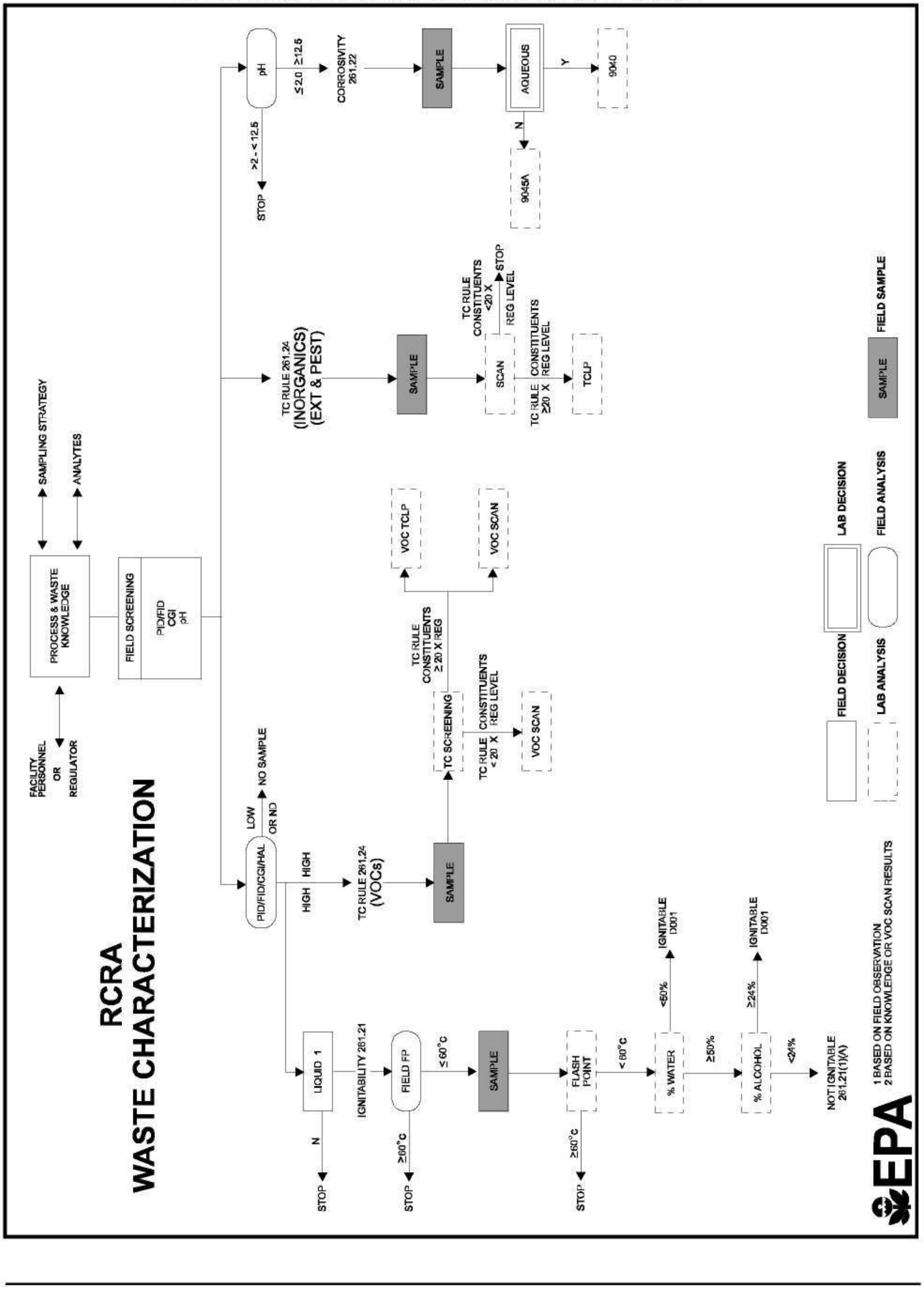
Other desired features of sampling equipment that should be considered; the ability to access the desired sampling locations, the ability to maintain sample integrity, the reactivity of equipment with the waste, and the ability to properly decontaminate the sampling apparatus. In addition, analytical requirements such as the sample handling and preparation to correctly analyze physical samples need to be considered. For solidified wastes, samples will often be required to undergo particle size reduction (PSR) prior to chemical analyses.

Sampling equipment should be selected to accommodate all of the known physical characteristics of concern or chosen such that the effect of any sampling bias is understood. Often because of a lack of preliminary information, varying field conditions, or waste heterogeneity, a piece of equipment selected during the investigations's planning phase may be unsuccessful for collecting a particular waste sample, and another piece of equipment will be required as a substitute. Any sampling bias or deficiencies resulting from the use of substituted equipment should be documented and reviewed with the data.

5.8.5 Field Screening

Field screening can be very effective in waste characterization and extremely valuable in selecting appropriate sampling locations and chemical analyses when little preliminary data exists. Field investigators routinely use observations, container labels/markings, physical characteristics, air monitoring equipment, pH meters/paper, and field flash point analyzers to confirm preliminary data or to decide on sampling locations during waste investigations. Figure 5-1 (RCRA Waste Characterization) is a flow diagram that depicts the process that field investigators may use to decide which waste containers to sample and what analyses to perform on particular samples when attempting to make RCRA Characteristic Waste determinations.

FIGURE 5-1
RCRA WASTE CHARACTERIZATION FLOW CHART



5.9 Wastewater Sampling Designs

Introduction

Wastewater sampling studies focus primarily on collecting wastewater samples of the influent or effluent at domestic and non-domestic facilities. Sampling activities are usually conducted for National Pollutant Discharge Elimination System (NPDES) compliance, compliance assistance, civil and criminal investigations, and water quality studies. Collection of wastewater samples is necessary in order to aobtain reliable data that can support compliance or enforcement activities. Specific sampling criteria for the collection of wastewater samples is given in Section 9 of this SOP.

The main considerations in developing a wastewater sampling strategy are:

- Type of study (Compliance Sampling Inspection, Diagnostic Evaluation, etc.).
- Regulated or target pollutants in the wastewater stream to be sampled.
- Selection of the projected sampling locations to satisfy the study objectives.
- Quality control criteria of the parameters to be sampled (oil and grease samples need to be collected as grab samples, trip blanks are taken into the field for the collection of samples for volatile organic compound analyses, etc.).

Complexity of the sampling program will vary with a number of factors. Some primary factors are:

- The number of sampling stations to be monitored. This will be dependent on NPDES permit requirements and the type of study (typically Toxic CSIs and DEs require a greater amount of sampling stations than a routine CSI).
- Special handling requirements of the target pollutants (sampling equipment for trace organic compounds require special cleaning procedures, etc.).
- Laboratory conducting the analyses (use of a contract laboratory may require shipping from the field, etc.).
- Accessibility to sampling stations.
- Process and operation criteria of the source generator (e.g., batch operation versus continuous discharge).
- Coordination of participating organizations in the study (e.g., state assistance with the sample collection).
- The length of time for sampling activities will dictate logistical considerations (e.g., shipment of samples, additional supplies, etc.).

5.10 UST and UIC Sampling Designs

UST Designs

The UST investigation focuses on determining whether a release from a tank(s) to the environment has occurred and usually includes both shallow ground water and subsurface soil sampling. Usually, the area of concern is not large, and if it is determined a release has occurred, delineation of a contaminant plume will probably be conducted during a subsequent investigation.

General sampling designs for soil sampling and ground water sampling are included in Section 5.5 and 5.6 of this SOP. However, specific considerations in developing a UST sampling strategy are:

- Identification of constituents in the tank.
- Identification of pollutants in ground water.
- Identification of pollutants in subsurface soil.

Complexity of the sampling program will vary based on a number of factors. Some primary factors are as follows:

- Size of the target area (One small tank or several large tanks).
- Hydro-geological conditions of the target area.
- Accessibility to potable and ground water monitoring wells.

UIC Designs

The UIC investigation focuses on determining the quality of the ground water in a target area and usually involves sampling ground water from deep wells. The UIC source is permitted and should have a monitoring well network.

General sampling designs for ground water sampling is included in 5.6 of this SOP. However, specific considerations in developing a UIC sampling strategy are:

- Identification of constituents being injected
- Identification of pollutants in ground water.
- Delineation of contamination plume.

Complexity of the sampling program will vary based on a number of factors. Some primary factors are as follows:

- Size of the target area.
- Hydro-geological conditions of the target area.
- Accessibility to potable and ground water monitoring wells.

5.11 Air Toxics Monitoring Designs

Ambient air monitoring strategies vary depending upon the monitoring objective. However, some elements are important for any air monitoring objective. Meteorology measurements should be taken concurrent with any major air monitoring effort. At a minimum, these measurements should include wind speed and wind direction.

At least on background sampling location (possibly more) should be selected to sample an air mass that is representative of the area before it is impacted by any emission from the site being monitored. Background samples should be collected concurrent with the site samples. An adequate number of sampling locations should be selected to assure representative sampling of the air mass, and provide enough data to adequately characterize the contaminant concentrations being emitted from the site. Generally, at a site with soil contamination, sampling should be conducted at the areas of high contaminant concentration, near the downwind fencelines, and/or at the fencelines near any residences.

Whenever possible, the sampling sites should be located in an open space and well away from any tall buildings. Attention should be given to avoiding potential local interference such as earth moving equipment, haul roads, etc.

Sampling methods for various ambient air pollutants are given in Section 14 of this SOP.

5.12 Data Quality Objectives

PERFORMANCE OBJECTIVE:

- To provide guidance on systematic planning and the use of DQO Process.
- To describe the steps, the purpose and activities of DQO Process

The US-EPA's Quality Assurance Division has developed guidance as part of its Quality System. One component of this Quality System is the requirement that field investigators use a systematic planning process as mandated in EPA Order 5360.1: Policy and Program Requirements for Mandatory Agency-wide Quality System (10), The US-EPA has developed a nonmandatory systematic planning process, the Data Quality Objectives (DQO) Process. The DQO process is an important tool for project managers, planners, and field investigators to define the type, quality, and quantity of data needed to make defensible decisions. The DQO process offers a way to plan field investigations so that the quality of data collected can be evaluated with respect to the data's intended use. For a detailed discussion of the complete DQO process, refer to the referenced guidance documents: Guidance for the Data Quality Objectives Process (1), Data Quality Objectives Process for Hazardous Waste Sites (2), and Standard Practice for Generation of Environmental Data Related to Waste Management Activities: Development of Data Quality Objectives (3).

The DQO process contains seven steps that will assist in preparing plans for environmental data collection activities (Figure 5-2). The steps are iterative and should be revisited as new information about a problem is learned. It provides a systematic approach for defining the requirements that a field investigation will attempt to fulfill. Such requirements may include when, where and how to collect samples, the number of samples, and the limits on tolerable error rates.

Figure 5-2. Steps of the DQO Process

1. State the Problem

2. Identify the Decision

3. Identify Inputs to the Decision

4. Define the Study Boundaries

5. Develop a Decision Rule

6. Specify Limits on Decision

7. Optimize the Design

Below are the steps, the purpose and recommended activities of DQO Process from the the US-EPA Data Quality Objectives Process for Hazardous Waste Sites (2).

Step 1. State the Problem

Purpose: Summarize the contamination problem that will require new environmental data, and identify resources available to resolve the problem.

Activities:

- Identify members of the planning team.
- Develop or refine the conceptual site model.
- Define any exposure scenarios.
- Specify the available resources and constraints.
- Write a brief summary of the contamination problem.

Step 2. Identify the Decision

Purpose: To identify the decision that requires new environmental data to address the contamination problem.

Activities:

- Identify the principal study question(s).
- Define alternative actions that could result from the resolution of the principal study question(s).
- Combine the principal study question and the alternative actions into a decision statement.
- Organize multiple decisions.

Step 3. Identify Inputs to the Decision

Purpose: To identify information that will be required to support the decision and specify which inputs require new environmental measurements.

Activities:

- Identify the information that will be required to resolve the decision statement.
- Determine the sources for each item of information identified.
- Identify the information needed to establish the action level(s).
- Confirm the appropriate analytical methods exist to provide the necessary data.

Step 4. Define the Study Boundaries

Purpose: To define the spatial and temporal boundaries that data must represent to support the decision.

Activities:

- Specify the characteristics that define the population of interest.
- Define the geographical area which the decision statement applies.
- When appropriate, divide the population into strata that have relatively homogenous characteristics.
- Determine the time frame to which the decision applies.

- Determine when to collect the data.
- Define the scale of the decision making.
- Identify any practical constraints on data collection.

Step 5. Develop a Decision Rule

Purpose: Develop a logical "If ..., then ..." statement that defines the conditions that would cause the decision maker to choose among alternate actions.

Activities:

- Specify the parameter(s) that characterizes the population of interest.
- Specify the action level for the decision.
- Confirm the measurement detection limits will allow reliable comparisons with action level.
- Combine the outputs from the previous DQO steps and develop a decision rule.

Step 6. Specify Limits of Decision Errors

Purpose: To specify the decision maker's tolerable limits on decision errors, which are used to establish performance goals for limiting uncertainty in the data. Note that a probabilistic sampling design is necessary to develop limits on decision errors.

Activities:

- Determine the possible range of the parameter of interest.
- Define both types of decision errors and their potential consequences and select the baseline condition.
- Specify a range of possible parameter values where the consequences of a false negative decsion error are relatively minor (the gray region).
- Assign probability values to points above and below the action level that reflect the tolerable probability for the occurrence of decision errors.

Step 7. Optimize the Design for Obtaining Data

Purpose: To identify resource-effective sampling and analysis design for generating data that are expected to satisfy the DQO's.

Activities:

- Review the DQO outputs and existing environmental data.
- Develop general data collection design alternatives.
- Formulate the mathematical expression necessary for each design alternative.
- Select the sample size that satisfies the DQOs for each design alternative.
- Select the most resource-effective design that satisfies all DQOs.
- Document the operational details and theoretical assumptions of the selected design in the study plan or quality assurance project plan (QAPP).

There are several benefits of using the DQO process including; providing a reliable methodology for clarifying how decisions about the site will be supported by environmental data and for establishing site-specific performance criteria for these decisions. Other benefits are: it helps conserve resources by determining which data collection and analytical methods are most appropriate, and it provides investigators with an end-point to make defensible decisions.

The DQO process has both qualitative and quantitative components. The qualitative steps encourage logical and practical planning for environmental data collection activities while the quantitative steps use statistical methods to design a data collection operation that will efficiently control the probability of making an incorrect decision. Although the quantitative steps of the DQO process are important, investigators and decision makers may choose not to apply statistics to every environmental field investigation. In some cases, the planning team may only utilize the qualitative steps of the DQO process during the investigation planning phases to generate authoritative data which may be used to confirm site characteristics.

5.13 Specific Sample Collection Quality Control Procedures

5.13.1 Introduction

This subsection provides guidelines for establishing quality control procedures for sampling activities. Strict adherence to all of the standard operating procedures outlined in this subsection form the basis for an acceptable sampling quality assurance program.

5.13.2 Experience Requirements

There is no substitute for field experience. Therefore, all professional and paraprofessional investigators shall have the equivalent of six months field experience before they are permitted to select sampling sites on their own initiative. This field experience shall be gained by on-the-job training using the "buddy" system. Each new investigator should accompany an experienced employee on as many different types of field studies as possible. During this training period, the new employee will be permitted to perform all facets of field investigations, including sampling, under the direction and supervision of senior investigators.

5.13.3 Traceability Requirements

All sample collection activities shall be traceable through field records to the person collecting the sample and to the specific piece of sampling equipment (where appropriate) used to collect that sample. All maintenance and calibration records for sampling equipment (where appropriate) shall be kept so that they are similarly traceable. See Sections 3.1 through 3.6 for specific procedures to be utilized that insure traceability.

5.13.4 Chain-of-Custody

Specific chain-of-custody procedures are included in Sections 3.1 through 3.6 of this SOP. These procedures will insure that evidence collected during an investigation will withstand scrutiny during litigation. To assure that procedures are being followed, it is recommended that field investigators or their designees audit chain-of-custody entries, tags, field notes, and any other recorded information for accuracy.

5.13.5 Sampling Equipment Construction Material

Sampling equipment construction materials can affect sample analytical results. Materials used must not contaminate the sample being collected and must be easily decontaminated so that samples are not cross-contaminated.

5.13.6 Sample Preservation

Samples for some analyses must be preserved in order to maintain their integrity. Preservatives required for routine analyses of samples collected are given in Appendix A of this SOP. All chemical preservatives used will be supplied by the Region 4 laboratory. All samples requiring preservation should be preserved immediately upon collection in the field. Samples that **should not** be preserved in the field are:

- Those collected within a hazardous waste site that are known or thought to be highly contaminated with toxic materials which may be highly reactive. Barrel, drum, closed container, spillage, or other source samples from hazardous waste sites are not to be preserved with any chemical. These samples may be preserved by placing the sample container on ice, if necessary.

- Those that have extremely low or high pH or samples that may generate potentially dangerous gases if they were preserved using the procedures given in Appendix A.

- Those for metals analyses which are shipped by air shall not be preserved with nitric acid in excess of the amount specified in Appendix A.

All samples preserved with chemicals shall be clearly identified by indication on the sample tag that the sample is preserved. If samples normally requiring preservation were not preserved, field records should clearly specify the reason.

5.13.7 Special Precautions for Trace Contaminant Sampling

Some contaminants can be detected in the parts per billion and/or parts per trillion range. Extreme care must be taken to prevent cross-contamination of these samples. The following precautions shall be taken when trace contaminants are of concern:

- A clean pair of new, non-powdered, disposable latex gloves will be worn each time a different location is sampled and the gloves should be donned immediately prior to sampling. The gloves should not come into contact with the media being sampled.

- Sample containers for source samples or samples suspected of containing high concentrations of contaminants shall be placed in separate plastic bags immediately after collecting, tagging, etc.

- If possible, ambient samples and source samples should be collected by different field teams. If different field teams cannot be used, all ambient samples shall be collected first and placed in separate ice chests or shipping containers. Samples of waste or highly contaminated samples shall never be placed in the same ice chest as environmental samples. Ice chests or shipping containers for source samples or samples suspected to contain high concentrations of contaminants shall be lined with new, clean, plastic bags.

- If possible, one member of the field sampling team should take all the notes, fill out tags, etc., while the other members collect the samples.

- When sampling surface waters, the water sample should always be collected before the sediment sample is collected.

- Sample collection activities should proceed progressively from the least suspected contaminated area to the most suspected contaminated area.

- Investigators should use equipment constructed of Teflon®, stainless steel, or glass that has been properly pre-cleaned (Appendix B) for collection of samples for trace metals or organic compounds analyses. Teflon® or glass is preferred for collecting samples where trace metals are of concern. Equipment constructed of plastic or PVC shall not be used to collect samples for trace organic compounds analyses.

5.13.8 Sample Handling and Mixing

After collection, all sample handling should be minimized. Investigators should use extreme care to ensure that samples are not contaminated. If samples are placed in an ice chest, investigators should ensure that melted ice cannot cause the sample containers to become submerged, as this may result in sample cross-contamination. Plastic bags, such as Zip-Lock® bags or similar plastic bags sealed with tape, should be used when small sample containers (e.g., VOC vials or bacterial samples) are placed in ice chests to prevent cross-contamination.

Once a sample has been collected, it may have to be transferred into separate containers for different analyses. The best way to transfer liquid samples is to continually stir the sample contents with a clean pipette or pre-cleaned Teflon® rod and allow the contents to be alternately siphoned into respective sample containers using Teflon® or PVC (Tygon® type) tubing (and a siphon bulb to start the flow). Teflon® must be used when analyses for organic compounds or trace metals are to be conducted. Any device used for stirring, or tubing used for siphoning, must be cleaned in the same manner as other equipment (Appendix B). However, samples collected for volatile organic compound, oil and grease, bacteria, sulfides, and phenols analyses may not be transferred using this procedure.

It is extremely important that waste (when appropriate), soil and sediment samples be mixed thoroughly to ensure that the sample is as representative as possible of the sample media. The most common method of mixing is referred to as quartering. The quartering procedure should be performed as follows:

1. The material in the sample pan should be divided into quarters and each quarter should be mixed individually.

2. Two quarters should then be mixed to form halves.

3. The two halves should be mixed to form a homogenous matrix .

This procedure should be repeated several times until the sample is adequately mixed. If round bowls are used for sample mixing, adequate mixing is achieved by stirring the material in a circular fashion, reversing direction, and occasionally turning the material over.

5.13.9 Special Handling of Samples for Volatile Organic Compounds (VOCs) Analysis

Water samples to be analyzed for volatile organic compounds should be stored in 40-ml septum vials with screw cap and Teflon®-silicone disk in the cap to prevent contamination of the sample by the cap. The disks should be placed in the caps (Teflon® side to be in contact with the sample) in the laboratory prior to the beginning of the sampling program.

The vials should be completely filled to prevent volatilization, and extreme caution should be exercised when filling a vial to avoid any turbulence which could also produce volatilization. The sample should be carefully poured down the side of the vial to minimize turbulence. As a rule, it is best to gently pour the last few drops into the vial so that surface tension holds the water in a convex meniscus. The cap is then applied and some overflow is lost, but the air space in the bottle is eliminated. After capping, turn the bottle over and tap it to check for bubbles. If any bubbles are present, repeat the procedure with another clean 40-ml vial. Since the VOC vials are pre-preserved, caution should be exercised when the vials are used as the collection device for surface water samples in order to prevent the loss of the preservative. When collecting water samples for VOCs. Three 40-ml vials containing preservative should be filled the with sample.

Soil samples for VOC analyses should be collected and handled as specified in section 12.4. Soil and sediment samples collected for VOC analyses should <u>not</u> be mixed.

5.13.10 Estimating Variability

<u>Spacial Variability</u>

The following spacial duplicate sampling procedures should be used during the collection of samples as a measure of variability within the area represented by the sample. When appropriate, spacial duplicate grab and/or composite samples should be collected during major investigations and studies conducted by the Branch. A "major study" would include all investigations where more than twenty (20) samples were collected, or those studies where the study objectives dictate that additional quality control samples be collected. No more than ten percent of all samples should be collected as spacial duplicates. These samples should be collected at the same time, using the same procedures, the same type of equipment, and in the same types of containers as the original samples, but collected from a different location within the area represented by the original. They should also be preserved in the same manner and submitted for the same analyses as the required samples. The collection of spacial duplicate composite samples requires that the sample aliquots be arrayed in a manner different from the original sample and spaced within the same area of representativeness. Data from spacial duplicates will be examined by the lead investigator to determine if the samples represent the areas intended in the project work plan.

<u>Temporal Variability</u>

When required, temporal variability at a given sampling location will be measured by collecting temporal duplicate samples. These samples will be collected from the same sampling location, using the same techniques and the same type of equipment, but at a time different from the original sample. The time selected for the temporal duplicate sample will be within the same span of time for which the original sample is designed to be representative in the project work plan. Data from temporal duplicates will be examined by the project leader to determine if samples represent the time span intended in the project work plan.

<u>Sample Handling Variability</u>

The effectiveness of sample handling techniques will be measured by collecting split and blank samples.

<u>Split Samples</u>

Split samples will be collected by initially collecting twice as much material as is normally collected for a sample. After mixing, the material will be apportioned into two sets of containers. Both sets of containers will be submitted for analyses with one set designated as an "original sample", the other designated as a "split sample". Data from split samples will be examined by the Quality Assurance Officer to determine sample handling variability. On large studies (more than 20 samples), no more than 10 percent of all samples will be collected as split samples.

Blank Samples

The following blank samples will be prepared by the laboratory and obtained by the project leader prior to traveling to a sample site.

1. Water Sample VOC Trip Blank -- A water sample VOC trip blank is required for every study where water samples are collected for VOC analysis. Two sealed preserved (or unpreserved if appropriate) 40-ml VOC vials will be transported to the field. For routine studies these samples will be prepared by lab personnel. Investigators shall request that these samples be provided at least one week in advance of scheduled field investigations and inspections and never (except in emergency situations) less than two days in advance of scheduled field investigations and inspections. These samples should not be picked up earlier than the morning of departure for the scheduled inspection/investigation. These field blanks will be handled and treated in the same manner as the water samples collected for volatile organic compounds analysis on that particular study. These samples will be clearly identified on sample tags and Chain-of-Custody Records as trip blanks.

2. Soil Sample VOC Trip Blank -- A soil sample VOC trip blank is required for every study where soil samples are collected for VOC analysis. The required containers are specified in section 12.4. The preparation and pick up of this sample will be the same as for the water sample VOC trip blank. Encore® containers (two for SESD laboratory or 3 for CLP) will be transported to the field. These field blanks will be handled and treated by Branch personnel in the same manner as the soil samples collected for volatile organic compounds analysis on that particular study. These samples will be clearly identified on sample tags and Chain-Of-Custody Records as trip blanks.

The following blanks are prepared in the field:

1. Inorganic Sample Preservative Blanks -- Metals and general inorganic sample containers filled with analyte-free water will be transported to the field and preserved and submitted for the same analyses as the other inorganic samples collected. These samples will be clearly identified as preservatives blanks on sample tags and the Chain-Of-Custody Record(s). At least one preservative blank for each type of preserved sample should be collected at the end of routine field investigations. A minimum of one preservative blank should be prepared in the field at the beginning and end of all major field investigations that last more than one week.

2. Equipment Field Blanks -- When field cleaning equipment is required during a sampling investigation, a piece of the field-cleaned equipment will be selected for collection of a rinse blank. At least one rinse blank will be collected during each week of sampling operations. After the piece of equipment has been field cleaned and prior to its being used for sample operations, it will be rinsed with organic/analyte free water. The rinse water will be collected and submitted for analyses of all constituents for which normal samples collected with that piece of equipment are being analyzed.

3. Organic/Analyte Free Water System Blanks -- When using a portable organic-free water generating system in the field, a sample of the raw source water and water generated will be collected at least once during each week of operations. The collected water sample will be submitted for analyses of all constituents for which normal samples are being analyzed.

4. Material Blanks -- When construction materials are being used on a site in such a way as to have a potential impact on constituent concentrations in the sample, a sample of the materials will be submitted for analyses. An example of a situation where construction blanks are required is monitoring well construction. In this situation all materials used in well construction should be submitted for analyses (e.g., grout, sand, tap water, etc.).

5. Automatic Sampler Blanks -- In general, cleaning procedures outlined in Appendix B of this SOP should be adequate to insure sample integrity. However, it is the standard practice of the Branch to submit automatic sampler blanks for analyses when automatic samplers are used to collect samples for organic compounds and metals analyses. Automatic sampler blanks for other standard analyses may be submitted in the event of a special investigation (ie, criminal or civil).

The Quality Assurance Officer will inform the project leaders and management when blank samples are found to be unacceptably contaminated. The Quality Assurance Officer will immediately initiate an investigation to determine the cause of the problem. The results of this investigation will be promptly reported to appropriate personnel so that corrective action and/or qualifications to the data can be initiated.

5.13.11 Special Quality Control Procedures for Water Samples for Extractable Organic Compounds, Pesticides, or Herbicides Analyses (Matrix Duplicate)

Duplicate water samples shall be submitted to the laboratory for extractable organic compounds, pesticides, and/or herbicides analyses from at least one sampling location per project and laboratory used. These samples should be collected from a location expected to be relatively free from contamination, since the samples will be used for laboratory quality control purposes. The duplicate samples should be clearly identified as "Duplicate Sample for Matrix Spike" on the sample tag, Chain-Of-Custody Record, in the field logbook, and on the Contract Laboratory Program (CLP) Traffic Report Form (if appropriate). This procedure shall be followed for all projects where water samples are collected for the indicated analyses.

5.13.12 Special Quality Control Procedures for EPA Contract Laboratories

On a case-by-case basis, field investigators may be required to collect split samples (or duplicate samples if appropriate) for analyses by both the Region 4 laboratory and contract laboratories. The split samples are to be submitted to the Region 4 laboratory using established procedures. The contract laboratory involved shall not be notified that samples were split, i.e., there should be no indication on Chain-Of-Custody Records or CLP Traffic Report Forms submitted to the contract laboratories that these samples were split with the Region 4 laboratory.

5.13.13 Special Quality Control Procedures for Dioxins and Furans

All samples collected for dioxins and furans analyses are analyzed by other EPA laboratories or through contract laboratories. The Region 4 laboratory does not conduct in-house analyses for dioxins and furans. The Region 4 laboratory should be consulted for the current quality control procedures for dioxin and furan samples prior to the sampling event.

5.14 Internal Quality Control Procedures

5.14.1 Introduction

The focus of this subsection is on Field Equipment Center (FEC) operations involving preparation of sampling and support equipment for field operations as well as for field data generated under the Specific Sample Collection Quality Control Procedures discussed in Section 5.13. Quality control checks of these operations insure that field sampling teams are provided with equipment that is suitable for sampling use, and that field sampling is conducted using proper procedures.

5.14.2 Traceability Requirements

Records, in the form of bound notebooks, will be kept by FEC personnel documenting the dates of operations and the person performing operations for the following:

- Organic/Analyte Free Water System Maintenance (Field and FEC Systems) – Maintenance on field systems will be performed immediately following every major study, or at least once per calendar quarter. FEC system maintenance will be performed at least once per calendar quarter.

- Air Monitoring Instrumentation Checkouts -- Pre-loadout checks on air monitoring instrumentation will be recorded each time they are performed. Discrepancies will be immediately reported to the Branch Safety Officer.

- Self Contained Breathing Apparatus (SCBA) Checkouts -- Pre-loadout checks on SCBAs will be recorded when they are performed. SCBA checkouts will be performed at least once per calendar quarter in the absence of loadout requests. Any discrepancies will be reported immediately to the Branch Safety Officer.

- Other Equipment Maintenance -- Maintenance performed on equipment other than that listed above will be recorded in a logbook for miscellaneous field equipment. All required repairs will be reported to the FEC coordinator.

- Sampling Containers and Latex Gloves -- A record will be kept of shipments received of sampling containers and latex gloves. Containers and gloves will be recorded by lot numbers. Upon receipt, the Quality Assurance (QA) Officer will be notified. Containers and gloves within a received lot will not be used until they have been checked by the QA Officer.

All equipment cleaned and wrapped for field use will be marked with the date on which preparation was completed. Equipment will be stored in the FEC in specified areas to minimize the risk of contamination while awaiting use.

5.14.3 Specific Quality Control Checks

At least once per calendar quarter, the QA Officer will conduct the following checks and issue a written report on the results.

1. Collect and submit for analyses samples of each lot of containers received during that quarter. Bottles from each lot will be tagged and sealed, then submitted for the following analyses:

   One-Gallon Amber – metals, cyanide, extractable organics, and pesticides.

   8-oz. Glass -- metals, cyanide, extractable organics, and pesticides.

   1-Liter Polyethylene -- metals and cyanide.

   Latex glove samples will be collected as rinse blanks using organic/analyte free water. The rinsate will be submitted for analyses of VOCs, metals, cyanide, extractable organics, and pesticides. A new glove will be rinsed for each parameter (e.g., one glove for VOC sample, another glove for metals, etc.) to avoid dilution of potential contaminants on the gloves.

2. Collect and submit for analyses a sample of water from the FEC organic/analyte free water system. The sample will be submitted for analyses of VOCs, metals, cyanide, extractable organics, and pesticides.

3. Collect and submit for analyses a rinsate blank of at least one piece of sampling or sample related equipment stored at the FEC. The sample will submitted for analyses of VOCs, metals, cyanide, extractable organics, and pesticides.

4. Collect the results of field quality control samples from the project leaders for the quarter. Normally, field quality control samples consist of the following:

   - Field split samples (not to include inter-lab splits);
   - Water VOC trip blank samples;
   - Soil VOC trip blank samples;
   - Inorganic sample preservative blanks;
   - Equipment field rinse blanks;
   - Field organic/analyte free water system blanks; and
   - Material blanks.

The QA Officer will evaluate all data received and immediately attempt to resolve any problems found. A written report will be issued on the quality control checks during each calendar quarter. The report will be submitted to appropriate personnel.

5.15 Investigation Derived Waste (IDW)

5.15.1 Types of IDW

Materials which may become IDW are:

- Personnel protective equipment (PPE) -- This includes disposable coveralls, gloves, booties, respirator canisters, splash suits, etc.

- Disposable equipment -- This includes plastic ground and equipment covers, aluminum foil, conduit pipe, composite liquid waste samplers (COLIWASAs), Teflon® tubing, broken or unused sample containers, sample container boxes, tape, etc.

- Soil cuttings from drilling or hand augering.

- Drilling mud or water used for water rotary drilling.

- Ground water obtained through well development or well purging.

- Cleaning fluids such as spent solvents and washwater.

- Packing and shipping materials.

Table 5.15.1 lists the types of IDW commonly generated during investigations, and current disposal practices.

5.15.2 Management of Non-Hazardous IDW

Disposal of non-hazardous IDW from hazardous waste sites should be addressed in the study plan. To reduce the volume for transportation back to the FEC, it may be necessary to compact the waste into a reusable container, such as a 55-gallon drum.

If the waste is from an active facility, permission should be sought from the operator of the facility to place the non-hazardous PPE, disposable equipment, and/or paper/cardboard wastes into the facilities' dumpsters. If necessary, these materials may be placed into municipal dumpsters, with the permission of the owner. These materials may also be taken to a nearby permitted landfill. On larger studies, waste hauling services may be obtained and a dumpster located at the study site. Non-hazardous IDW may also be buried on site near the contamination source, with the burial location noted in the field logbook.

Disposal of non-hazardous IDW such as drill cuttings, purge or development water, decontamination washwater, drilling muds, etc., should be specified in the approved study plan. It is recommended that these materials be placed into a unit with an environmental permit such as a landfill or sanitary sewer. These materials must not be placed into dumpsters. If the facility at which the study is being conducted is active, permission should be sought to place these types of IDW into the facilities treatment system. It may be feasible to spread drill cuttings around the borehole, or if the well is temporary, to place the cuttings back into the borehole. Cuttings, purge water, or development water may also be placed in a pit in or near the source area. Monitoring well purge or development water may also be poured onto the ground downgradient of the monitoring well. Purge water from private potable wells which are in service may be discharged directly onto the ground surface.

The minimum requirements of this subsection are:

- Liquid and soil/sediment IDW must be containerized and analyzed before disposal.
- The collection, handling, and proposed disposal method must be specified in the approved study plan.

5.15.3 Management of Hazardous IDW

Disposal of hazardous or suspected hazardous IDW must be specified in the approved study plan. Hazardous IDW must be disposed as specified in US-EPA regulations. If appropriate, these wastes may be placed back in an active facility waste treatment system. These wastes may also be disposed of in the source area from which they originated, if doing so does not endanger human health and the environment.

If on-site disposal is not feasible, and if the wastes are suspected to be hazardous, appropriate tests must be conducted to make that determination. If they are determined to be hazardous wastes, they must be properly contained and labeled. They may be stored on the site for a maximum of 90 days before they must be manifested and shipped to a permitted treatment or disposal facility. Generation of hazardous IDW must be anticipated, if possible, to permit arrangements for proper containerization, labeling, transportation, and disposal/treatment in accordance with US-EPA regulations.

The generation of hazardous IDW should be minimized to conserve Branch resources. Most routine studies should not produce any hazardous IDW, with the exception of spent solvents and possibly purged ground water. Care should be taken to keep non-hazardous materials segregated from hazardous waste contaminated materials. The volume of spent solvents produced during equipment decontamination should be controlled by applying only the minimum amount of solvent necessary, and capturing it separately from the washwater.

At a minimum the requirements of the management of hazardous IDW are as follows:

- Spent solvents must be returned to the FEC for proper disposal or recycling.
- All hazardous IDW must be containerized. Proper handling and disposal should be arranged prior to commencement of field activities.

TABLE 5.15.1
DISPOSAL of IDW

TYPE	HAZARDOUS	NON-HAZARDOUS
PPE-Disposable	Containerize in plastic 5-gallon bucket with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise return to FEC for proper disposal.	Place waste in trash bag. Place in dumpster with permission of site operator, otherwise return to FEC for disposal in dumpster.
PPE-Reusable	Decontaminate as per Appendix B, if possible. If the equipment cannot be decontaminated, containerize in plastic 5-gallon bucket with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise return to FEC for proper disposal.	Decontaminate as per Appendix B.
Spent Solvents	Containerize in original containers. Clearly identify contents. Leave on-site with permission of site operator, otherwise return to FEC for proper disposal.	N/A
Soil Cuttings	Containerize in 55-gallon drum with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with WMD site manager for testing and disposal.	Containerize in 55-gallon drum with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with site manager for testing and disposal.
Groundwater	Containerize in 55-gallon drum with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with WMD site manager for testing and disposal.	Containerize in 55-gallon drum with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with site manager for testing and disposal.
Decontamination Water	Containerize in 55-gallon drum with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with WMD site manager for testing and disposal.	Containerize in 55-gallon drum with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with site manager for testing and disposal.
Disposable Equipment	Containerize in 55-gallon drum or 5-gallon plastic bucket with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with WMD site manager for testing and disposal.	Containerize in 55-gallon drum or 5-gallon plastic bucket with tight-fitting lid. Identify and leave on-site with permission of site operator, otherwise arrange with site manager for testing and disposal.
Trash	N/A	Place waste in trash bag. Place in dumpster with permission of site operator, otherwise return to FEC for disposal in dumpster.

5.16 References

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5. Gilbert, Richard O., Statistical Methods for Environmental Pollution Monitoring, Van Nostrand Reinhold Co., New York, NY, 1987.

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7. US-EPA, Characterization of Hazardous Waste Sites - A Methods Manual, Volume 1 - Site Investigations (EPA 600/4-84/075).

8. US-EPA, Guidance of Choosing a Sampling Design for Environmental Data Collection, (EPA QA/G5-5S, Peer Review Draft, August 2000)

9. Kittrell, F.W., A Practical Guide to Water Quality Studies.

10. US-EPA Order 5360.1, Policy and Program Requirements for the Mandatory Agency-wide Quality System, May 5, 2000.

SECTION 6
DESIGN AND INSTALLATION OF MONITORING WELLS

PERFORMANCE OBJECTIVES:

- Ensure that the monitoring well will provide high quality samples.
- Ensure that the monitoring well is constructed properly and will last the duration of the project.
- Ensure that the monitoring well will not serve as a conduit for contaminants to migrate between aquifers.

6.1 Introduction

Methods and procedures for the design and installation of monitoring wells to be employed in Region 4 are contained in this section. They are to be used for all permanent and temporary monitoring wells installed for collecting ground water samples for analysis.

6.2 Permanent Monitoring Wells - Design Considerations

The design and installation of permanent monitoring wells involves drilling into various types of geologic formations that exhibit varying subsurface conditions. Designing and installing permanent monitoring wells in these geologic environments may require several different drilling methods and installation procedures. The selection of drilling methods and installation procedures should be based on field data collected during a hydrogeologic site investigation and/or a search of existing data. Each permanent monitoring well should be designed and installed to function properly throughout the duration of the monitoring program. When designing monitoring wells, the following should be considered:

- short-and long-term objectives;
- purpose(s) of the well(s);
- probable duration of the monitoring program;
- contaminants likely to be monitored;
- types of well construction materials to be used;
- surface and subsurface geologic conditions;
- properties of the aquifer(s) to be monitored;
- well screen placement;
- general site conditions; and
- potential site health and safety hazards.

Each of the above considerations can be expanded into many subtopics depending on the complexity of the project. In designing permanent monitoring wells, the most reliable, obtainable data should be utilized. Once the data have been assembled and the well design(s) completed, a drilling method(s) has to be selected. The preferred drilling procedures for installing permanent monitoring wells are those that temporarily case the borehole during drilling and the construction of the well, e.g. hollow-stem augers and sonic methods. However, site conditions may not always be amenable to using these methods When this occurs, alternate methods should be selected that will perform the job equally as well. The following discussion of methods and procedures for designing and installing monitoring wells will cover the different aspects of selecting materials, drilling boreholes, and installing monitoring devices.

6.3 Drilling Methods

The following drilling methods are listed in general order of preference; however, final selection should be based on actual site conditions. In all cases, the proper field QA/QC procedures should be initiated before and during drilling to minimize the potential for contamination. These QA/QC procedures include, but are not limited to, sampling and analyzing of all drilling materials such as drilling muds, filter sand, bentonite pellets, grouts, and any potable water introduced during drilling.

6.3.1 Hollow-Stem Auger

This type of auger consists of a hollow, steel stem or shaft with a continuous, spiraled steel flight, welded onto the exterior stem. A hollow auger bit, generally with carbide teeth, disturbs soil material when rotated, whereupon the spiral flights transport the cuttings to the surface. This method is best suited in soils that have a tendency to collapse when disturbed. A monitoring well can be installed inside of hollow-stem augers with little or no concern for the caving potential of the soils and/or water table. However, retracting augers in caving sand conditions while installing monitoring wells can be extremely difficult or impossible, especially since the augers have to be extracted without being rotated. If caving sands exist during monitoring well installations, a drilling rig must be used that has enough power to extract the augers from the borehole without having to rotate them. A bottom plug, trap door, or pilot bit assembly can be fastened onto the bottom of the augers to keep out most of the soils and/or water that have a tendency to clog the bottom of the augers during drilling. Potable water (analyzed for contaminants of concern) may be poured into the augers (where applicable) to equalize pressure so that the inflow of formation materials and water will be held to a minimum when the bottom plug is released. Water-tight center plugs are not acceptable because they create suction when extracted from the augers. This suction forces or pulls cuttings and formation materials into the augers, defeating the purpose of the center plug. Augering without a center plug or pilot bit assembly is permitted, provided that the soil plug, formed in the bottom of the augers, is removed before sampling or installing well casings. Removing the soil plug from the augers can be accomplished by washing out the plug using a side discharge rotary bit, or augering out the plug with a solid-stem auger bit sized to fit inside the hollow-stem auger. The type of bottom plug, trap door, or pilot bit assembly proposed for the drilling activity should be approved by a senior field geologist prior to drilling operations. Boreholes can be augered to depths of 150 feet or more (depending on the auger size), but generally boreholes are augered to depths less than 100 feet.

6.3.2 Solid-Stem Auger

This type of auger consists of a solid stem or shaft with a continuous spiraled steel flight, welded on the outer side of the stem, connected to an auger bit and when rotated transports cuttings to the surface. This auger method is used in cohesive and semi-cohesive soils that do not have a tendency to collapse when disturbed. Boreholes can be augered to depths of 200 feet or more (depending on the auger size), but generally boreholes are augered to depths less than 150 feet.

Both of the previously discussed auger methods can be used in unconsolidated soils and semi-consolidated (weathered rock) soils, but not in competent rock. Each method can be employed without introducing foreign materials into the borehole such as water and drilling fluids, minimizing the potential for cross contamination. Minimizing the risk of cross contamination is one of the most important factors to consider when selecting the appropriate drilling method(s) for a project.

6.3.3 Sonic Methods.

These methods alternately advance concentric hollow drill stems using rotation in conjunction with axial vibration of the drill stem. After each stage of drill stem advancement, the inner string is removed with a core of drill cuttings while the outer string remains to hold the borehole open. The cuttings can be removed nearly intact from the inner casing for examination of stratigraphy prior to disposal. Because there are no auger flights to increase the drill stem diameter, the quantity of cuttings removed from the hole is minimized as compared to hollow stem augering. Smearing of the formation materials on the borehole walls is reduced as well. This drilling method is useful in a variety of materials, from flowing sands to heavily consolidated or indurated formations.

In flowing sands, the drill casings can be filled and/or pressurized with potable water to prevent excess entry of formation materials into the drill string. The same QA/QC requirements for sampling of material introduced to the borehole apply as in other drilling methods. Because the amount of water introduced into the borehole can be significant, an approximation of the water used in the drilling process should be logged for use in estimating appropriate well development withdrawal.

Sonic drilling allows a larger diameter temporary casing to be set into a confining layer while drilling proceeds into deeper aquifers. This temporary casing is then removed during the grouting operation. In many cases this will be acceptable technique. However, the level of contamination in the upper aquifer, the importance of the lower aquifers for drinking water uses, the permeability and continuity of the confining layer, and state regulations should be taken into account when specifying this practice as opposed to permanent outer casing placed into the confining unit. Note that when using the temporary casing practice, it is critical that grout be mixed and placed properly as specified elsewhere in this section.

Because the total borehole diameter in sonic drilling is only incrementally larger than the inner casing diameter, particular care should be taken that the well casing is placed in the center of the drill stem while placing the filter pack. Centralizers may be required to facilitate this in the case of deep wells with PVC casing.

6.3.4 Rotary Methods

These methods consists of a drill pipe or drill stem coupled to a drilling bit that rotates and cuts through the soils. The cuttings produced from the rotation of the drilling bit are transported to the surface by drilling fluids which generally consist of water, drilling mud, or air. The water, drilling mud, or air are forced down through the drill pipe, and out through the bottom of the drilling bit. The cuttings are then lifted to the surface between the borehole wall and the drill pipe, (or within a concentric drill stem in reverse rotary). The drilling fluids not only force the cuttings to the surface but also keeps the drilling bit cool. When considering this method, it is important to evaluate the potential for contamination when fluids and/or air are introduced into the borehole. If the rotary method is selected as one of the drilling methods, water rotary is the preferred method, followed by air rotary and mud rotary.

Due to the introduction of the various circulating fluids, the use of rotary methods requires that the potential for contamination by these fluids be evaluated. Water and mud rotary methods present the possibility of trace contamination of halogenated compounds when municipal water supplies are used as a potable water source. Air rotary drilling can introduce contamination through the use of lubricants or entrained material in the air stream. In any of the rotary (or sonic) methods, care must be exercised in the selection and use of compounds to prevent galling of drill stem threads.

Water Rotary

When using water rotary, potable water (that has been analyzed for contaminants of concern) should be used. If potable water (or a higher quality water) is not available on-site, then potable water will have to be transported to the site or an alternative drilling method will have to be selected. Water rotary is the preferred rotary method because potable water is the only fluid introduced into the borehole during drilling. Water does not clog the formation materials reducing well development time; however this potable water will flow out into the surrounding formation materials (if permeable) and mix with the natural formation water. This mixing of the drilling water and the natural formation water should be evaluated when determining the drilling method. Generally, a large majority of the drilling water will be recovered during well development.

Air Rotary

Air rotary drilling uses air as a drilling fluid to entrain cuttings and carry them to the surface. High air velocities, and consequently large air volumes and compressor horsepower are required. 'Down-the-hole' (DTH) percussion hammers driven by the air stream can be used with this method to rapidly penetrate bedrock materials. Where a casing through unconsolidated material is required to prevent borehole collapse, it can be driven in conjunction with advancement of the drill stem.

When using air rotary drilling in any zone of potential contamination, dual-tube reverse circulation with a cyclone velocity dissipater for cuttings containment and separation is the preferred method. Allowing cuttings to blow uncontrolled from the borehole (as with the conventional air rotary method) is not acceptable.

When using air rotary, the issue of contaminants being introduced into the borehole by the air stream must be addressed. Screw compressor systems should have a coalescing filter system in good working order to capture excess entrained compressor oils. The lubricant to be used with 'down-the-hole' hammers as well as thread lubricants to be used on drill stem should be evaluated for their potential impact on analytical samples.

Mud Rotary

Mud rotary is the least preferred rotary method because contamination can be introduced into the borehole from the constituents in the drilling mud, cross contamination can occur along the borehole column, and it is very difficult to remove the drilling mud from the borehole after drilling and during well development. The drilling mud can also carry contaminates from a contaminated zone to an uncontaminated zone thereby cross-contaminating the borehole. If mud rotary is selected, only potable water and pure (no additives) bentonite drilling muds should be used. All materials used should have adequate documentation as to manufacturer's recommendations and product constituents. QA/QC samples of drilling muds and potable water should be sampled at a point of discharge from the circulation system to assure that pumps and piping systems are not contributing cross-contamination from previous use.

6.3.5 Other Methods

Other methods such as the cable-tool method, jetting method, and boring (bucket auger) method are available. If these and/or other methods are selected for monitoring well installations, they should be approved by a senior field geologist before field work is initiated.

6.4 Borehole Construction

6.4.1 Annular Space

The borehole or hollow stem auger should be of sufficient diameter so that well construction can proceed without major difficulties. For open boreholes, the annular space should be approximately 2" to allow the uniform deposition of well materials around the screen and riser, and to allow the passage of tremie pipes and well materials without unduly disturbing the borehole wall. For example, a 2" nominal diameter (nom.) casing would require a 6" inside diameter (ID) borehole.

In hollow stem augers and sonic method drill casing, the ID should be of sufficient size to allow the passage of the tremie pipe to be used for well grout placement, as well as free passage of filter sands or bentonite pellets dropped through the auger or casing. In general, 4-1/4" ID should be the minimum size used for placement of 2"nom. casing and 8-1/4" ID for 4"nom. casing. Larger augers should be used where installation difficulties due to geologic conditions or greater depths are anticipated, e.g. larger augers might be required to place a bentonite pellet seal through a long water column.

6.4.2 Overdrilling the Borehole

Sometimes it is necessary to overdrill the borehole so that any soils that have not been removed or that have fallen into the borehole during augering or drill stem retrieval, will fall to the bottom of the borehole below the depth where the filter pack and well screen are to be placed. Normally, 3 to 5 feet is sufficient for overdrilling. The borehole can also be overdrilled to allow for an extra space or a "sump" area below the well screen. This "sump" area provides a space to attach a 5 or 10 foot section of well casing to the bottom of the well screen. The extra space or "sump" below the well screen serves as a catch basin or storage area for sediment that flows into the well and drops out of suspension. These "sumps" are added to the well screens when the wells are screened in aquifers that are naturally turbid and will not yield clear formation water (free of visible sediment) even after extensive development. The sediment can then be periodically pumped out of the "sump" preventing the well screen from clogging or "silting up". If the borehole is overdrilled deeper than desired, it can be backfilled to the designed depth with bentonite pellets, chips, or the filter sand that is to be used for the filter pack.

6.4.3 Filter Pack Placement

When placing the filter pack into the borehole, a minimum of 6-inches of the filter pack material should be placed under the bottom of the well screen to provide a firm footing and an unrestricted flow under the screened area. Also, the filter pack should extend a minimum of 2-feet above the top of the well screen to allow for settling and to isolate the screened interval from the grouting material. In open boreholes, the filter pack should be placed by the tremie or positive displacement method. Placing the filter pack by pouring the sand into an open drill stem is acceptable with the use hollow stem augers, and other methods where the borehole is temporarily cased down to the filter pack.

6.4.4 Filter Pack Seal-Bentonite Pellet Seal (Plug)

Bentonite pellets consist of ground, dried bentonite compacted into pellets available in several sizes. Bentonite pellets are compressed to a bulk density of 70-80 lbs/cu.ft. and hydrate to a 30% min. solids material.

Where neat cement grouts are to be used, the placement of a bentonite pellet seal above the filter pack is mandatory to prevent the possibility of grout infiltration into the screened interval prior to setting. Bentonite chips or other sealing products should not be substituted in this application. Where bentonite grouts are to be used, the placement of a bentonite pellet seal is optional, but desirable.

Since the pellets begin hydrating rapidly, they are very difficult to place by the tremie method. They may be placed by pouring slowly into either open boreholes or hollow stem augers. A tamper should be used to ensure that the material is being placed properly and to rapidly break up any pellet bridging that occurs.

Pellet seals should be designed for a two foot thickness of dry pellets above the filter pack. Hydration may extend the height of the seal. Where neat cement grouts are to be used the pellets should be hydrated for eight hours, or the manufacturer's recommended hydration time, whichever is greater. Where the water table is temporarily below the pellet seal, potable (or higher quality) water should be added repeatedly to hydrate the pellets prior to grouting.

6.4.5 Grouting the Annular Space

The annular space between the casing and the borehole wall should be filled with either a 30% solids bentonite grout, a neat cement grout, or a cement/bentonite grout. Each type of grout selected should be evaluated as to its intended use and integrity.

Bentonite grout shall be a 30% solids pure bentonite grout with a minimum density of 10 lb/gal. Drilling muds are not acceptable for grouting. The grout should be placed into the borehole, by the tremie method, from the top of the bentonite seal to within 2-feet of the ground surface or below the frost line, whichever is the greater depth. The bentonite pellet seal or filter pack should not be disturbed during grout placement, either by the use of a side discharge port on the tremie tube, or by maintaining clearance between the bottom of the tremie tube and the bentonite seal or filter pack. The grout should be allowed to cure for a minimum of 24 hours before the concrete surface pad is installed. The preferred method of achieving proper solids content is by measurement of ingredients per the manufacturer's specifications during mixing. Bentonite grouts should have a minimum density of 10 lbs/gal to ensure proper gelling and low permeability. The density of the first batch of grout should be measured while mixing to verify proper measurement of ingredients. In addition, the grouting operation should not cease until the bentonite grout flowing out of the borehole has a minimum density of 10 lbs/gal. A mud balance should be used to measure the specified grout density of the bentonite grout. Estimating the grout density is not acceptable.

Neat cement grouts are generally dictated where a high level of dissolved solids or a particular dissolved constituent would prevent proper gelling of a bentonite grout. Neat cement grouts should be mixed using 6.5 to 7 gallons of water per 94-lb bag of Type 1 Portland cement. The addition of bentonite (5 to 10 percent) to the cement grout is generally used to delay the "setting" time and may not be needed in all applications. The specific mixtures and other types of cement and/or grout proposed should be evaluated on a case by case basis by a senior field geologist.

6.4.6 Above Ground Riser Pipe and Outer Protective Casing

The well casing, when installed and grouted, should extend above the ground surface a minimum of 2.5 feet. A vent hole should be drilled into the top of the well casing cap to permit pressure equalization, if applicable. An outer protective casing should be installed into the borehole after the annular grout has cured for at least 24 hours. The outer protective casing should be of steel construction with a hinged, locking cap. Generally, outer protective casings used over 2-inch well casings are 4 inches square by 5 feet long. Similarly, protective casings used over 4-inch well casings are 6 inches square and 5 feet long. Round protective casings are also acceptable. All protective casings should have sufficient clearance around the inner well casings, so that the outer protective casings will not come into contact with the inner well casings after installation. The protective casings should have a minimum of two weep holes for drainage. These weep holes should be a minimum 1/4-inch in diameter and drilled into the protective casings just above the top of the concrete surface pads to prevent water from standing inside of the protective casings. Protective casings made of aluminum or other soft metals are normally not acceptable because they are not strong enough to resist tampering. Aluminum protective casing may be used in very corrosive environments such as coastal areas.

A protective casing is installed by pouring concrete into the borehole on top of the grout. The protective casing is then pushed into the wet concrete and borehole a minimum of 2 feet. Extra concrete may be needed to fill the inside of the protective casing so that the level of the concrete inside of the protective casing is at or above the level of the surface pad. In areas where frost heave of the surface pad is possible, the protective casing should first be pressed into the top surface of the grout seal and concrete poured around the protective casing. A granular material such as sand or gravel can then be used to fill the space between the riser and protective casing. The protective casing should extend approximately 3 feet above the ground surface or to a height so that the cap of the inner well casing is exposed when the protective casing is opened. At each site, all locks on the outer protective casings should be keyed alike.

6.4.7 Concrete Surface Pad

A concrete surface pad should be installed around each well at the same time as the outer protective casing is being installed. The surface pad should be formed around the well casing. Concrete should be placed into the pad forms and into the borehole (on top of the grout) in one operation making a contiguous unit. The size of the concrete surface pad is dependent on the well casing size. If the well casing is 2 inches in diameter, the pad should be 3 feet x 3 feet x 4 inches. If the well casing is 4 inches in diameter, the pad should be 4 feet x 4 feet x 6 inches. Round concrete surface pads are also acceptable. The finished pad should be slightly sloped so that drainage will flow away from the protective casing and off of the pad. A minimum of one inch of the finished pad should be below grade to prevent washing and undermining by soil erosion.

6.4.8 Surface Protection-Bumper Guards

If the monitoring wells are located in a high traffic area, a minimum of three bumper guards consisting of steel pipes 3 to 4 inches in diameter and a minimum 5-foot length should be installed. These bumper guards should be installed to a minimum depth of 2 feet below the ground surface in a concrete footing and extend a minimum of 3 feet above ground surface. Concrete should also be placed into the steel pipe to provide additional strength. Substantial steel rails and/or other steel materials can be used in place of steel pipe. Welding bars between the bumper posts can provide additional strength and protection in high traffic areas, but the protective bumpers should not be connected to the protective casing.

6.5 Construction Techniques

6.5.1 Well Installation

The borehole should be bored, drilled, or augered as close to vertical as possible, and checked with a plumb bob or level. Deviation from plumb should be within 1° per 50ft of depth. Slanted boreholes will not be acceptable unless specified in the design. The depth and volume of the borehole, including the overdrilling if applicable, should have been calculated and the appropriate materials procured prior to drilling activities. The well casings should be secured to the well screen by flush-jointed threads and placed into the borehole and plumbed by the use of centralizers and/or a plumb bob and level. Another method of placing the well screen and casings into the borehole and plumbing it at the same time is to suspend the string of well screen and casings in the borehole by means of the wireline on the drill rig. The string of well screen and casings can be placed into the borehole and plumbed in one easy operation. This wireline method is especially useful if the borehole is deep and a long string of well screen and casings have to be set and plumbed. No lubricating oils or grease should be used on casing threads. Teflon tape can be used to wrap the threads to insure a tight fit and minimize leakage. No glue of any type should be used to secure casing joints. Teflon "O" rings can also be used to insure a tight fit and minimize leakage; however, "O" rings made of other materials are not acceptable if the well is going to be sampled for organic compound analyses. Before the well screen and casings are placed on the bottom of the borehole, at least 6 inches of filter material should be placed at the bottom of the borehole to serve as a firm footing. The string of well screen and casings should then be placed into the borehole and plumbed. Centralizers can be used to plumb a well, but centralizers should be placed so that the placement of the filter pack, bentonite pellet seal, and annular grout will not be hindered. Centralizers placed in the wrong locations can cause bridging during material placement. Monitoring wells less than 50 feet deep generally do not need centralizers. If centralizers are used they should be placed below the well screen and above the bentonite pellet seal. The specific placement intervals should be decided based on site conditions. When installing the well screen and casings through hollow-stem augers, the augers should be slowly extracted as the filter pack, bentonite seal, and grout are tremied and/or poured into place. The gradual extraction of the augers will allow the materials being placed in the augers, to flow out of the bottom of the augers into the borehole. If the augers are not gradually extracted, the materials (sand, pellets, etc.) will accumulate at the bottom of the augers causing potential bridging problems. After the string of well screen and casing is plumb, the filter material should then be placed around the well screen (by the tremie method in open boreholes) up to the designated depth. After the filter pack has been installed, the bentonite pellet seal (if used) should be placed directly on top of the filter pack to an unhydrated thickness of two feet. When installing the seal for use with neat cement grouts, the bentonite pellet seal should be allowed to hydrate a minimum of eight hours or the manufacturer's recommended hydration time, whichever is longer. After the pellet seal has hydrated for the specified time, the grout should then be pumped by the tremie method into the annular space around the casings up to within 2 feet of the ground surface or below the frostline, whichever is the greater depth. The grout should be allowed to set for a minimum of 24 hours before the surface pad and protective casing are installed. After the surface pad and protective casing are installed, bumper guards should be installed (if needed). The bumper guards should be placed around the concrete surface pad in a configuration that provides maximum protection to the well. Each piece of steel pipe or approved material should be installed into an 8-to 10-inch diameter hole, to a minimum depth of 2 feet below ground surface, and filled with concrete. As previously stated, the bumper guard should extend above the ground surface a minimum of 3 feet. The total length of each bumper guard should be a minimum of 5 feet.

After the wells have been installed, the outer protective casing should be painted with a highly visible enamel paint. The wells should be permanently marked with the well number, date installed, site name, elevation, etc., either on the cover or an appropriate place that will not be easily damaged and/or vandalized.

If the monitoring wells are installed in a high traffic area such as a parking lot, in a residential yard, or along the side of a road it may be desirable to finish the wells to the ground surface and install water-tight flush mounted traffic and/or man-hole covers. Flush mounted traffic and man-hole covers are designed to extend from the ground surface down into the concrete plug around the well casing. Although flush mounted covers may vary in design, they should have seals that make the unit water-tight when closed and secured. The flush mounted covers should be installed as far above grade as practical to minimize standing water and promote runoff. Permanent identification markings should be placed on the covers or in the concrete plug around the cover. Expansive sealing plugs may be used in the well riser to prevent infiltration of any water that might enter the flush cover.

6.5.2 Double Cased Wells

Double cased wells should be constructed when there is reason to believe that interconnection of two aquifers by well construction may cause cross contamination, and/or when flowing sands make it impossible to install a monitoring well using conventional methods. A pilot borehole should be bored through the overburden and/or the contaminated zone into the clay confining layer or bedrock. An outer casing (sometimes called surface or pilot casings) should then be placed into the borehole and sealed with grout. The borehole and outer casing should extend into tight clay a minimum of two feet and into <u>competent</u> bedrock a minimum of 1 foot. The total depths into the clay or bedrock will vary, depending on the plasticity of the clay and the extent of weathering and\or fracturing of the bedrock. The final depths should be approved by a senior field geologist. The size of the outer casing should be of sufficient inside diameter (ID) to contain the inner casing, and the 2-inch minimum annular space. In addition, the borehole should be of sufficient size to contain the outer casing and the 2-inch minimum outer annular space, if applicable.

The outer casing should be grouted by the tremie method from the bottom to within 2 feet of the ground surface. The grout should be pumped into the annular space between the outer casing and the borehole wall. This can be accomplished by either placing the tremie tube in the annular space and pumping the grout from the bottom of the borehole to the surface, or placing a grout shoe or plug inside the casing at the bottom of the borehole and pumping the grout through the bottom grout plug and up the annular space on the outside of the casing. If the outer casing is set into very tight clay, both of the above methods might have to be used, because the clay usually forms a tight seal in the bottom and around the outside of the casing preventing grout from flowing freely during grout injection. On the other hand, outer casing set into bedrock normally will have space enough to allow grout to flow freely during injection. A minimum of 24 hours should be allowed for the grout plug (seal) to cure before attempting to drill through it. The grout mixture used to seal the outer annular space should be either a neat cement, cement/bentonite, cement/sand, or a 30% solids bentonite grout. However, the seal or plug at the bottom of the borehole and outer casing should consist of a Type I portland cement/bentonite or cement/sand mixture. The use of a pure bentonite grout for a bottom plug or seal is not acceptable, because the bentonite grout cures to a gel-like material, and is not rigid enough to withstand the stresses of drilling. When drilling through the seal, care should be taken to avoid cracking, shattering, and/or washing out the seal, which will be discussed in the next section. If caving conditions exist so that the outer casing cannot be sufficiently sealed by grouting, the outer casing should be driven into place and a grout seal placed in the bottom of the casing. Removal of outer casings, which are sometimes called temporary surface casings, after the well screens and casings have been installed and grouted is not acceptable. Trying to remove outer surface casings after the inner casings have been grouted could jeopardize the structural integrity of the well.

Bedrock Wells

The installation of monitoring wells into bedrock can be accomplished in two ways:

1. The first method is to drill or bore a pilot borehole through the soil overburden into the bedrock. An outer casing is then installed into the borehole by setting it into the bedrock, and grouting it into place as described in the previous section. After the grout has set, the borehole can then be advanced through the grout seal into the bedrock. The preferred method of advancing the borehole into the bedrock is rock coring. Rock coring makes a smooth, round hole through the seal and into the bedrock without cracking and/or shattering the seal. Roller cone bits are used in soft bedrock, but extreme caution should be taken when using a roller cone bit to advance through the grout seal in the bottom of the borehole because excessive water and "down" pressure can cause cracking, eroding (washing), and/or shattering of the seal. Low volume air hammers may be used to advance the borehole, but they have a tendency to shatter the seal because of the hammering action. If the structural integrity of the grout seal is in question, a pressure test can be utilized to check for leaks. A visual test can also be made by examining the cement/concrete core that is collected when the seal is cored with a diamond coring bit. If the seal leaks (detected by pressure testing) and/ or the core is cracked or shattered, or if no core is recovered because of washing, excessive down pressure, etc., the seal is not acceptable. The concern over the structural integrity of the grout seal applies to all double cased wells. Any proposed method of double casing and/or seal testing will be evaluated on its own merits, and will have to be approved by a senior field geologist before and during drilling activities, if applicable. When the drilling is complete, the finished well will consist of an open borehole from the ground surface to the bottom of the well. There is no inner casing, and the outer surface casing, installed down into bedrock, extends above the ground surface, and also serves as the outer protective casing. If the protective casing becomes cracked or is sheared off at the ground surface, the well is open to direct contamination from the ground surface and will have to be repaired immediately or abandoned. Another limitation to the open rock well is that the entire bedrock interval serves as the monitoring zone. In this situation, it is very difficult or even impossible to monitor a specific zone, because the contaminants being monitored could be diluted to the extent of being nondetectable. The installation of open bedrock wells is generally not acceptable in the Superfund and RCRA programs, because of the uncontrolled monitoring intervals. However, some site conditions might exist, especially in cavernous limestone areas (Karst topography) or in areas of highly fractured bedrock, where the installation of the filter pack and its structural integrity are questionable. Under these conditions the design of an open bedrock well may be warranted.

2. The second method of installing a monitoring well into bedrock is to install the outer surface casing and drill the borehole (by an approved method) into bedrock, and then install an inner casing and well screen with the filter pack, bentonite seal, and annular grout. The well is completed with a surface protective casing and concrete pad. This well installation method gives the flexibility of isolating the monitoring zone(s) and minimizing inter-aquifer flow. In addition, it gives structural integrity to the well, especially in unstable areas (steeply dipping shales, etc.) where the bedrock has a tendency to shift or move when disturbed. Omitting the filter pack around the well screen is a general practice in some open rock borehole installations, especially in drinking water and irrigation wells. However, without the filter pack to protect the screened interval, sediment particles from the well installation and/or from the monitoring zone could clog the well screen and/or fill the screened portion of the well rendering it inoperable. Also, the filter pack serves as a barrier between the bentonite seal and the screened interval. Rubber inflatable packers have been used to place the bentonite seal when the filter pack is omitted, but the packers have to remain in the well permanently and, over a period of time, will decompose and possibly contribute contaminants to the monitoring zone.

6.6 Well Construction Materials

6.6.1 Introduction

Well construction materials are chosen based on the goals and objectives of the proposed monitoring program and the geologic conditions at the site(s). In this section, the different types of available materials will be discussed.

6.6.2 Well Screen and Casing Materials

When selecting the materials for well construction, the prime concern should be to select materials that will not contribute foreign constituents, or remove contaminants of concern from the ground water. If the monitoring program is designed to analyze for organic compounds, stainless steel materials are the preferred choice. If the monitoring program calls for the analyses of only inorganic compounds or the contaminants or formation are highly corrosive, then rigid PVC materials meeting National Sanitary Foundation (NSF) Standard 14 type WC (Well Casing) are acceptable. PVC materials may be acceptable for monitoring identified organic compounds in a soluble aqueous phase where incompatibilities are known to not exist. EPA document EPA/540/S-95/503, Nonaqueous Phase Liquids Compatibility with Materials Used in Well Construction, Sampling, and Remediation (http://www.epa.gov/ada/download/issue/napl.pdf) should be used for guidance in this area and in the use of PVC with Nonaqueous Phase Liquids (NAPLs). Another concern is to select materials that will be rugged enough to endure the entire monitoring period. Site conditions will generally dictate the kind of materials that can be used. A preliminary field investigation should be conducted to determine the geologic conditions, so that the most suitable materials can be selected. The best grade or highest quality material for that particular application should be selected. Each manufacturer can supply the qualitative data for each grade of material that is being considered. All materials selected for monitoring well installation should be evaluated and approved by a senior field geologist prior to field activities.

Well screen and casing materials generally used in monitoring well construction on RCRA and Superfund sites are listed in order of preference:

(1) Stainless Steel (304 or 316)
(2) Rigid PVC meeting NSF Standard 14 (type WC)
(3) Other (where applicable)

There are other materials used for well screens and casings such as black iron, carbon steel, galvanized steel, and fiberglass, but these materials are not recommended for use in long term monitoring programs at hazardous waste sites, because of their low resistance to chemical attack and potential constituent contribution to the ground water. In cases where a driven casing is used, or a high strength outer casing is needed, carbon steel may be acceptable in non-corrosive aquifers. This outer casing should have threaded connections. Welding casing is not an acceptable practice unless all relevant safety issues have been adequately addressed.

The minimum nominal casing size for most permanent monitoring wells will be 2". Where a complete program of installation, monitoring, and abandonment is being designed, smaller wells may be installed if suitable purging and sampling equipment for the smaller diameter wells can be specified and obtained. The length of well screens in permanent monitoring wells should be long enough to effectively monitor the interval or zone of interest. However, well screens designed for long term monitoring purposes should normally not be less than 5 feet in length. Well screens less that 5 feet long are acceptable in only temporary monitoring wells where ground water samples are collected for screening purposes.

6.6.3 Filter Pack Materials

The filter pack materials should consist of clean, rounded to well-rounded, hard, insoluble particles of siliceous composition. The required grain-size distribution or particle sizes of the filter pack materials should be selected based upon a sieve analysis conducted on the soil samples collected from the aquifer materials and/or the formation(s) to be monitored. Filter pack materials should not be acceptable unless proper documentation can be furnished as to the composition, grain-size distribution, cleaning procedure, and chemical analysis. If a data search reveals that there is enough existing data to adequately design the well screen and filter pack, then it may not be necessary to conduct a sieve analysis on the formation materials to be monitored. However, all data and design proposals will be evaluated and approved by a senior staff geologist before field activities begin.

6.6.4 Filter Pack and Well Screen Design

The majority of monitoring wells are installed in shallow ground water aquifers that consist of silts, clays, and sands in various combinations. These shallow aquifers are not generally characteristic of sand aquifers used for drinking water. Therefore, modifications to the procedures used for the design of water well filter packs may be required. In cases where insufficient experience exists with local or similar materials, the filter pack and well screen design should be based on the results of a sieve analysis conducted on soil samples collected from the aquifer or the formation(s) that will be monitored.

In formations consisting primarily of fines (silts and clays), the procedures for water well screen design may result in requirements for filter packs and screen slot sizes that are not available. In those cases the selection of 0.010" screen slots with a 20-40 sand filter pack, or 0.005" screen slots with 100 sand filter pack for very fine formations, will be acceptable practice. Table 6.6.1 provides size specifications for the selection of sand packs for fine formation materials. ASTM standard D5092, <u>Design and Installation of Ground Water Monitoring Wells in Aquifers</u>, may be consulted for further guidance on specifications for sand appropriate for these applications.

Table 6.6.1
Sand Pack Specifications

Screen Opening (in)	Sand Pack Mesh Name	1% Passing Size (d-1) (in)	10% Passing Size (d-10) (in)	30% Passing Size (d-30) (in)	Derived 60% Passing Size (d-60) (in)	Range for Uniformity Coefficient
0.005"-0.006"	100	3.5 - 4.7	5.5 - 6.7	6.7 - 8.3	8.5 - 13.4	1.3 - 2.0
0.010"	20-40	9.8 - 13.8	15.7 - 19.7	19.7 -23.6	20 - 31.5	1.1 - 1.6

The following procedure should be used in coarser grained formations.

The data from the sieve analysis are plotted on a grain-size distribution graph, and a grain-size distribution curve is generated. From this grain-size distribution curve, the uniformity coefficient (Cu) of the aquifer material is determined. The Cu is the ratio of the 60 percent finer material (d60) to the 10 percent finer material (d10)

$$Cu = (d60/d10)$$

The Cu ratio is a way of grading or rating the uniformity of grain size. For example, a Cu of unity means that the individual grain sizes of the material are nearly all the same, while a Cu with a large number means a large range of sizes. As a general rule, a Cu of 2.5 or less should be used in designing the filter pack and well screen.

Before designing the filter pack and well screen, the following factors should be considered:

1. Select the well screen slot openings that will retain 90 percent of the filter pack material.

2. The filter pack material should be of the size that minimizes head losses through the pack and also prevents excessive sediment (sand, silt, clay) movement into the well.

3. A filter material of varying grain sizes is not acceptable because the smaller particles fill the spaces between the larger particles thereby reducing the void spaces and increasing resistance to flow. Therefore, filter material of the same grain size and well rounded is preferred.

4. The filter pack design is based on the gradation of the finest aquifer materials being analyzed.

Steps to design a filter pack in aquifers:

1. Construct a grain-size distribution curve, on a grain-size distribution graph, from the sieve analysis of the aquifer materials. The filter pack design (as stated above) is based on the gradation of the finest aquifer materials.

2. Multiply the d30 size from the grain-size distribution graph by a factor of four to nine (Pack-Aquifer ratio). A factor of four is used if the formation is fine-grained and uniform (Cu is less than 3), six if it is coarse-grained and non-uniform, and up to nine if it is highly non-uniform and contains silt. Head losses through filter packs increase as the Pack-Aquifer(P-A) ratios decrease. In order to design a fairly stable filter pack with a minimum head loss, the d30 size should be multiplied by a factor of four.

3. Plot the point from step 2 on the d30 abscissa of a grain-size distribution graph and draw a smooth curve with a uniformity coefficient of approximately 2.5.

4. A curve for the permissible limits of the filter pack is drawn plus or minus 8 per cent of the desired curve with the Cu of 2.5.

5. Select the slot openings for the well screen that will retain 90 per cent or more of the filter pack material.

The specific steps and procedures for sieve analysis and filter pack design can be found in soil mechanics, ground water, and water well design books. The staff geologists and/or engineers should be responsible for the correct design of the monitoring wells and should be able to perform the design procedures.

6.7 Safety Procedures for Drilling Activities

A site health and safety plan should be developed and approved by the Branch Safety Officer or designee prior to any drilling activities, and should be followed during all drilling activities. The driller or designated safety person should be responsible for the safety of the drilling team performing the drilling activities. All personnel conducting drilling activities should be qualified in proper drilling and safety procedures. Before any drilling activity is initiated, the area should be surveyed with the necessary detection equipment to locate, flag, or mark, all under ground utilities such as electrical lines, natural gas lines, fuel tanks and lines, water lines, etc. Before operating the drill rig, a pilot hole should be dug (with hand equipment) to a depth of two to three feet to check for undetected utilities or buried objects. Proceed with caution until a safe depth is reached where utilities normally would not be buried. The following safety requirements should be adhered to while performing drilling activities:

1. All drilling personnel should wear safety hats, safety glasses, and steel toed boots. Ear plugs are required and will be provided by the safety officer or driller.

2. Work gloves (cotton, leather, etc.) should be worn when working around or while handling drilling equipment.

3. All personnel directly involved with the drilling rig(s) should know where the kill switch(s) is located in case of emergencies.

4. All personnel should stay clear of the drill rods or augers while in motion, and should not grab or attempt to attach a tool to the drill rods or augers until they have completely stopped rotating. Rod wipers, rather than gloves or bare hands should be used to remove mud, or other material, from drill stem as it is withdrawn from the borehole.

5. Do not hold drill rods or any part of the safety hammer assembly while taking standard penetration tests or while the hammer is being operated.

6. Do not lean against the drill rig or place hands on or near moving parts at the rear of the rig while it is operating.

7. Keep the drilling area clear of any excess debris, tools, or drilling equipment.

8. Do not climb on the drilling rig while it is being operated or attempt to repair the rig while it is being operated. The driller will direct all work on the rig.

9. Do not move or pick up any drilling equipment unless directed by the driller and/or the project leader.

10. Each drill rig will have a first-aid kit and a fire extinguisher located on the rig in a location quickly accessible for emergencies. All drilling personnel will be familiarized with their location.

11. Work clothes will be firm fitting, but comfortable and free of straps, loose ends, strings etc., that might catch on some moving part of the drill rig.

12. Rings or other jewelry will not be worn while working around the drill rig.

13. The drill rig should not be operated within a minimum distance of 20 feet of overhead electrical power lines and/or buried utilities that might cause a safety hazard. In addition, the drill rig should not be operated while there is lightening in the area of the drilling site. If an electrical storm moves in during drilling activities, vacate the area until it is safe to return.

6.8 Well Development

A newly completed monitoring well should not be developed for at least 24 hours after the surface pad and outer protective casing are installed. This will allow sufficient time for the well materials to cure before development procedures are initiated. The main purpose of developing new monitoring wells is to remove the residual materials remaining in the wells after installation has been completed, and to try to re-establish the natural hydraulic flow conditions of the formations which may have been disturbed by well construction, around the immediate vicinity of each well. A new monitoring well should be developed until the column of water in the well is free of visible sediment, and the pH, temperature, turbidity, and specific conductivity have stabilized. In most cases the above requirements can be satisfied; however, in some cases the pH, temperature, and specific conductivity may stabilize but the water remains turbid. In this case the well may still contain well construction materials, such as drilling mud in the form of a mud cake and/or formation soils, that have not been washed out of the borehole. Excessive or thick drilling muds can not be flushed out of a borehole with one or two well volumes of flushing. Continuous flushing over a period of several days may be necessary to complete the well development. If the well is pumped to dryness or near dryness, the water table should be allowed to sufficiently recover (to the static water level) before the next development period is initiated. Caution should be taken when using high rate pumps and/or large volume air compressors during well development because excessive high rate pumping and high air pressures can damage or destroy the well screen and filter pack. The onsite geologist should make the decision as to the development completion of each well. All field decisions should be documented in the field log book.

The following development procedures, listed in increasing order of the energy applied to the formation materials, are generally used to develop monitoring wells:

1. Bailing
2. Pumping/overpumping
3. Surging
4. Backwashing ("rawhiding")
5. Jetting
6. Compressed air (with appropriate filtering): airlift pumping and air surging

These developmental procedures can be used, individually or in combination, in order to achieve the most effective well development. In most cases, overpumping and surging will adequately develop the well without imparting undue forces on the formation or well materials. Except when compressed air is being used for well development, sampling can be initiated as soon as the ground water has re-equilibrated, is free of visible sediment, and the water quality parameters have stabilized. Since site conditions vary, even between wells, a general rule-of-thumb is to wait 24 hours after development to sample a new monitoring well. Wells developed with stressful measures may require as long as a 7-day interval before sampling. In particular, air surge developed wells require 48 hours or longer after development so that the formation can dispel the compressed air and restabilize to pre-well construction conditions. Because of the danger of introducing contaminants with the airstream, the possibility of entraining air in the aquifer, and the violent forces imparted to the formation, air surging is the least desired method of development. The selected development method(s) should be approved by a senior field geologist before any well installation activities are initiated.

6.9 Well Abandonment

When a decision is made to abandon a monitoring well, the borehole should be sealed in such a manner that the well can not act as a conduit for migration of contaminants from the ground surface to the water table or between aquifers. To properly abandon a well, the preferred method is to completely remove the well casing and screen from the borehole, clean out the borehole, and backfill with a cement or bentonite grout, neat cement, or concrete. In order to comply with state well abandonment requirements, the appropriate state agency should be notified (if applicable) of monitoring well abandonment. However, some state requirements are not explicit, so a technically sound well abandonment method should be designed based on the site geology, well casing materials, and general condition of the well(s).

6.9.1 Abandonment Procedures

As previously stated the preferred method should be to completely remove the well casing and screen from the borehole. This may be accomplished by augering with a hollow-stem auger over the well casing down to the bottom of the borehole, thereby removing the grout and filter pack materials from the hole. The well casing should then be removed from the hole with the drill rig. The clean borehole can then be backfilled with the appropriate grout material. The backfill material should be placed into the borehole from the bottom to the top by pressure grouting with the positive displacement method (tremie method). The top 2 feet of the borehole should be poured with concrete to insure a secure surface seal (plug). If the area has heavy traffic use, and/or the well locations need to be permanently marked, then a protective surface pad(s) and/or steel bumper guards should be installed. The concrete surface plug can also be recessed below ground surface if the potential for construction activities exists. This abandonment method can be accomplished on small diameter (1-inch to 4-inch) wells without too much difficulty. With wells having 6-inch or larger diameters, the use of hollow-stem augers for casing removal is very difficult or almost impossible. Instead of trying to ream the borehole with a hollow-stem auger, it is more practical to force a drill stem with a tapered wedge assembly or a solid-stem auger into the well casing and extract it out of the borehole. Wells with little or no grouted annular space and/or sound well casings can be removed in this manner. However, old wells with badly corroded casings and/or thickly grouted annular space have a tendency to twist and/or break-off in the borehole. When this occurs, the well will have to be grouted with the remaining casing left in the borehole. The preferred method in this case should be to pressure grout the borehole by placing the tremie tube to the bottom of the well casing, which will be the well screen or the bottom sump area below the well screen. The pressurized grout will be forced out through the well screen into the filter material and up the inside of the well casing sealing holes and breaks that are present. The tremie tube should be retracted slowly as the grout fills the casing. The well casing should be cut off even with the ground surface and filled with concrete to a depth of 2 feet below the surface. If the casing has been broken off below the surface, the grout should be tremied to within 2 feet of the surface and then finished to the ground surface with concrete. The surface pad or specified surface protection shall then be installed.

A PVC well casing may be more difficult to remove from the borehole than a metal casing, because of its brittleness. If the PVC well casing breaks during removal, the borehole should be cleaned out by using a drag bit or roller cone bit with the wet rotary method to grind the casing into small cuttings that will be flushed out of the borehole by water or drilling mud. Another method is to use a solid-stem auger with a carbide tooth bit to grind the PVC casing into small cuttings that will be brought to the surface on the rotating flights. After the casing materials have been removed from the borehole, the borehole should be cleaned out and pressure grouted with the approved grouting materials. As previously stated, the borehole should be finished with a concrete surface plug and adequate surface protection, unless directed otherwise.

6.10 Temporary Monitoring Well Installation

6.10.1 Introduction

Five types of temporary monitoring well installation techniques have been demonstrated as acceptable. The type selected for a particular site is dependent upon site conditions. The project leader and site geologist should be prepared to test temporary well installations on site and select the best solution. Temporary wells are cost effective, may be installed quickly, and provide a synoptic picture of ground water quality.

Temporary monitoring well locations are not permanently marked, nor are their elevations normally determined. Sand pack materials may or may not be used, but typically there is no bentonite seal, grout, surface completion, or extensive development (as it normally applies to permanent monitoring wells). Temporary wells are generally installed, purged, sampled, removed, and backfilled in a matter of hours.

Due to the nature of construction, turbidity levels may initially be high. However, these levels may be reduced by low flow purging and sampling techniques as described in Section 7.2.4.

Temporary wells may be left overnight, for sampling the following day, but the well must be secured. If the well is not sampled immediately after construction, the well should be purged prior to sampling as specified in Section 7.2.4.

6.10.2 Data Limitation

Temporary wells described in this section are best used for delineation of contaminant plumes, at a point in time, and for some site screening purposes. They are not intended to replace permanent monitoring wells. Perhaps the best use for temporary wells is in conjunction with a mobile laboratory, where quick analytical results can be used to delininate contaminant plumes.

6.10.3 Temporary Well Materials

Materials used in construction of temporary monitoring wells are the same standard materials used in the construction of permanent monitoring wells. Sand used for the filter pack (if any) should be as specified in Section 6.6.3. The well screen and casing should be stainless steel for ruggedness and suitability for steam cleaning and solvent rinsing. Other materials may be acceptable, on a case by case basis. Some commercially available temporary well materials, pre-packed riser, screen and filter pack assemblies are available commercially; however, these pre-assembled materials cannot be cleaned. Appropriate QA/QC must be performed to assure there will be no introduction of contamination.

6.10.4 Temporary Monitoring Well Borehole Construction

Borehole construction for temporary wells is as specified in Section 6.4, using a drill rig. Alternatively, boreholes may be constructed using hand augers or portable powered augers (generally limited to depths of ten feet or less). If a drill rig is used to advance the borehole, the augers must be pulled back the length of the well screen (or removed completely) prior to sampling. When hand augers are used, the borehole is advanced to the desired depth (or to the point where borehole collapse occurs). In situations where borehole collapse occurs, the auger bucket is typically left in the hole at the point of collapse while the temporary well is assembled. When the well is completely assembled, a final auger bucket of material is quickly removed and the well is immediately inserted into the borehole, pushing, as needed, to achieve maximum penetration into the saturated materials.

6.10.5 Temporary Monitoring Well Types

Five types of monitoring wells which have been shown to be acceptable are presented in the order of increasing difficulty to install and increasing cost:

No Filter Pack

This is the most common temporary well and is very effective in many situations. After the borehole is completed, the casing and screen are simply inserted. This is the most inexpensive and fastest well to install. This type well is extremely sensitive to turbidity fluctuations, because there is no filter pack. Care should be taken to not disturb the casing during purging and sampling.

Inner Filter Pack

This type differs from the "No Pack" only in that a filter pack is placed inside the screen to a level approximately 6 inches above the well screen. This ensures that all water within the casing has passed through the filter pack. For this type well to function properly, the static water level must be 6-12 inches above the filter pack.

Traditional Filter Pack

For this type, the screen and casing are inserted into the borehole, and the sand is poured into the annular space surrounding the screen and casing. Occasionally, it may be difficult to effectively place a filter pack around shallow open boreholes, due to collapse. This method requires more sand than the "inner filter pack" well, increasing material costs. As the filter pack is placed, it mixes with the muddy water in the borehole, which may increase the amount of time needed to purge the well to an acceptable level of turbidity.

Double Filter Pack

The borehole is advanced to the desired depth. As with the "inner filter pack" the well screen is filled with filter pack material and the well screen and casing inserted until the top of the filter pack is at least 6 inches below the water table. Filter pack material is poured into the annular space around the well screen. This type temporary well construction can be very effective in aquifers where fine silts or clays predominate. This construction technique takes longer to implement and uses more filter pack material than others previously discussed.

Well-in-a-Well

The borehole is advanced to the desired depth. At this point, a 1-inch well screen and sufficient riser is inserted into a 2-inch well screen with sufficient riser, and centered. Filter pack material is then placed into the annular space surrounding the 1-inch well screen, to approximately 6 inches above the screen. The well is then inserted into the borehole.

This system requires twice as much well screen and casing, with subsequent increase in material cost. The increased amount of well construction materials results in a corresponding increase in decontamination time and costs. If pre-packed wells are used, a higher degree of QA/QC will result in higher overall cost.

6.10.6 Backfilling

It is the generally accepted practice to backfill the borehole from the abandoned temporary well with the soil cuttings. Use of cuttings would not be an acceptable practice if waste materials were encountered or a confining layer was inadvertently breached. Likewise, where the borehole is adjacent to or, downslope of contaminated areas, the loose backfilled material could create a high permeability conduit for the contaminant migration. If for some reason the borehole cannot be backfilled with the soil cuttings, then the same protocols set forth in Section 6.9 should be applied. Section 5.15 should be referenced regarding disposal of IDW.

6.11 Temporary Monitoring Well Installation Using the Geoprobe® Screen Point 15 Groundwater Sampler

6.11.1 Introduction

The Geoprobe® Screen Point 15 Groundwater Sampler is a discrete interval ground water sampling device that can be pushed to pre-selected sampling depths in saturated, unconsolidated materials, opened and sampled as a temporary monitoring well. It is a sealed sample device, opened at the desired depth, yielding a representative, uncompromised sample from that depth. Using knock-out plugs, this method also allows for grouting of the push hole during sample tool retrieval after sample collection.

The Screen Point 15 sampler consist of four parts (drive point, screen, sampler sheath and drive head), with an assembled length of 52 inches (1321 mm) and a maximum OD of 1.5 inches (38 mm). When opened, it has an exposed screen length of 41 inches (1041 mm). It is typically pushed using 1.25-inch probe rod.

The following is a step-by-step description of the components and procedures used to install a Screen Point 15 Groundwater Sampler.

6.11.2 Assembly of Screen Point 15 Groundwater Sampler

1. Install O-ring on expendable point and firmly seat in the necked end of the sampler sheath.

2. Place a grout plug in the lower end of the screen section.

3. When using a stainless steel screen, place another O-ring in the groove on the upper end of the screen and slide it into the sampler sheath.

4. Place an O-ring on the bottom of the drive head and thread into the top of the sampler sheath.

5. The Screen Point 15 Groundwater Sampler is now assembled and ready to push for sample collection.

6.11.3 Installation of Screen Point 15 Groundwater Sampler

1. Attach drive cap to top of sampler and slowly drive it into the ground. Raise the hammer assembly, remove the drive cap and place an O-ring in the top groove of the drive head. Add a probe rod and continue push.

2. Continue to add probe rods until the desired sampling depth is reached.

3. When the desired sampling depth is reached, re-position the probe derrick and position either the casing puller assembly or the rod grip puller over the top of the top probe rod.

4. Thread a screen push adapter on an extension rod and attach sufficient additional extension rods to reach the top of the Screen Point 15 sampler. Add an extension handle to the top of the string of extension rods and run this into the probe rod, resting the screen push adapter on top of the sampler.

5. To expose the screened portion of the sampler, exert downward pressure on the sampler, using the extension rod and push adapter, while pulling the probe rod upward. To expose the entire open portion of the screen, pull the probe rod upward approximately 41 inches.

6. At this point, the Screen Point 15 Groundwater Sampler has been installed as a temporary well and may be sampled using appropriate ground water sampling methodology. EIB personnel typically use a peristaltic pump, utilizing low-flow methods, to collect ground water samples from these installations (see Section 7, Ground Water Sampling, for a detailed description of these techniques and methods).

6.11.4 Special Considerations for Screen Point 15 Installations

<u>Grouting</u>

In many applications, it may be appropriate to grout the abandoned probe hole where a Screen Point 15 sampler was installed. This is accomplished via pressure grouting through the probe rod during sampler retrieval. To accomplish this, the grout plug is knocked out of the bottom of the screen using a grout plug push adapter and a grout nozzle is fed through the probe rod, extending just below the bottom of the screen. As the probe rod and sampler are pulled, grout is injected in the open hole below the screen at a rate that just fills the open hole created by the pull. Teflon® grout plugs are used for all EIB investigations using this method of abandonment.

<u>Screen Material Selection</u>

Screen selection is also a consideration in sampling with the Screen Point 15 sampler. The screens are available in two materials, stainless steel and PVC. Because of stainless steel's durability, ability to be cleaned and re-used and overall inertness and compatibility with most contaminants, it is the choice of materials for all EIB investigations.

6.12 References

1. National Ground Water Association, Manual of Water Well Construction Practices, NGWA, Westerville, OH

2. US-EPA, Handbook of Suggested Practices for the Design and Installation of Ground-Water Monitoring Wells (EPA/600/4-89, March 1991)

3. ASTM, Standard Practice for Design and Installation of Ground water Monitoring Wells in Aquifers (D5092-90).

4. Driscoll, Fletcher, Ph.D., Groundwater and Wells, Johnson Division, St. Paul, MN, 1986

5. US-EPA,Nonaqueous Phase Liquids Compatibility with Materials Used in Well Construction, Sampling, and Remediation, (EPA/540/S-95/503, July 1995), (http://www.epa.gov/ada/download/issue/napl.pdf)

SECTION 7
GROUND WATER SAMPLING

PERFORMANCE OBJECTIVES:

- To collect a sample representative of ground water residing in the formation of interest.
- To reduce the potential bias caused by the sampling equipment used to obtain the sample.

7.1 Introduction

Ground water sampling may be required for a variety of reasons, such as examining potable or industrial water supplies, checking for and/or tracking contaminant plume movement in the vicinity of a land disposal or spill site, Resource Conservation Recovery Act (RCRA) compliance monitoring, or examining a site where historical information is minimal or non-existent but where it is thought that ground water contamination may have occurred.

Ground water samples are usually obtained from either temporarily or permanently installed ground water monitoring wells. They can also be obtained, however, anywhere ground water is present, such as in a pit or a dug or drilled hole.

Occasionally, the ground water source may not be in the ideal location to meet a particular objective (e.g., to track a contaminant plume). In that case, either a temporary or permanent monitoring well should be installed. An experienced and knowledgeable person will need to locate the well and supervise its installation so that samples will be representative of the ground water.

Additional guidance is given in RCRA Ground-Water Monitoring: Technical Guidance (1) and Chapter 11 of SW-846 (2). The ground water sampling procedures described in this SOP will meet or exceed the requirements of these documents.

Ground water sampling procedures can be sub-divided into two areas, purging and sampling, each of which has different goals and objectives. Within the topic of purging, it is necessary, because of the inherently different characteristics of the two types of wells, to address permanent and temporary wells separately. The procedures and techniques which follow in this section reflect these differences.

7.2 Purging

7.2.1 Purging and Purge Adequacy

Purging is the process of removing stagnant water from a monitoring well, immediately prior to sampling, causing its replacement by ground water from the adjacent formation, which is representative of actual aquifer conditions. In order to determine when a well has been adequately purged, field investigators should: 1) monitor the pH, specific conductance, temperature, and turbidity of the ground water removed during purging; and 2) observe and record the volume of water removed.

Prior to initiating the purge, the amount of water standing in the water column (water inside the well riser and screen) should be determined. To do this, the diameter of the well should be determined and the water level and total depth of the well are measured and recorded. Specific methodology for obtaining these measurements is found in Section 15.5 of this SOP. Once this information is obtained, the volume of water to be purged can be determined using one of several methods. One is the equation:

$$V = 0.041\ d^2h$$

Where: h = depth of water in feet
d = diameter of well in inches
V = volume of water in gallons

Alternatively, the volume may be determined using a casing volume per foot factor for the appropriate diameter well, similar to that in Table 7.2.1. The water level is subtracted from the total depth, providing the length of the water column. This length is multiplied by the factor in the Table 7.2.1 which corresponds to the appropriate well diameter, providing the amount of water, in gallons, contained in the well. Other acceptable methods include the use of nomographs or other equations or formulae.

With respect to volume, an adequate purge is normally achieved when three to five times the volume of standing water in the well has been removed. The field notes should reflect the single well volume calculations or determinations, according to one of the above methods, and a reference to the appropriate multiplication of that volume, i.e., a minimum three well volumes, clearly identified as a purge volume goal.

With respect to the ground water chemistry, an adequate purge is achieved when the pH, specific conductance, and temperature of the ground water have stabilized and the turbidity has either stabilized or is below 10 Nephelometric Turbidity Units (NTUs) (twice the Primary Drinking Water Standard of 5 NTUs). Although ten NTUs is normally considered the minimum goal for most ground water sampling objectives, 1 NTU has been shown to be easily achievable and reasonable attempts should be made to reach this level. Stabilization occurs when pH measurements remain constant within 0.1 Standard Unit (SU), specific conductance varies no more that 10 percent, and the temperature is constant for at least three consecutive readings. There are no criteria establishing how many sets of measurements are adequate for the determination of stability. If the calculated purge volume is small, the measurements should be taken frequently to provide a sufficient number of measurements to evaluate stability. If the purge volume is large, measurements taken every 15 minutes may be sufficient.

If, after three well volumes have been removed, the chemical parameters have not stabilized according to the above criteria, additional well volumes (up to five well volumes), should be removed. If the parameters have not stabilized within five volumes, it is at the discretion of the project leader whether or not to collect a sample or to continue purging. If after five well volumes, pH and conductivity have been stabilized and the turbidity is still decreasing and approaching an acceptable level, additional purging should be considered to obtain the best sample possible. The conditions of sampling should be noted in the field log.

TABLE 7.2.1
WELL CASING DIAMETER vs. VOLUME

WELL CASING DIAMETER 9 (INCHES) vs. VOLUME (GALS.)/FEET of WATER	
CASING	GALLONS/FT
1	0.041
2	0.163
3	0.367
4	0.653
5	1.02
6	1.469
7	1.999
8	2.611
9	3.305
10	4.08
11	4.934
12	5.875

In some situations, even with slow purge rates, a well may be pumped or bailed dry (evacuated). In these situations, this generally constitutes an adequate purge and the well can be sampled following sufficient recovery (enough volume to allow filling of all sample containers). It is not necessary that the well be evacuated three times before it is sampled. The pH, specific conductance, temperature, and turbidity should be measured, during collection of the sample from the recovered volume, as the measurements of record for the sampling event.

Attempts should be made to avoid purging wells to dryness. This can be accomplished, for example, by slowing the purge rate. If a well is pumped dry, it may result in the sample being comprised partially of water contained in the sand pack, which may be reflective, at least in part, of initial, stagnant conditions. In addition, as water re-enters a well that is in an evacuated condition, it may cascade down the sand pack or the well screen, stripping volatile organic constituents that may be present and/or introducing soil fines into the water column.

It is particularly important that wells be sampled as soon as possible after purging. If adequate volume is available, the well must be sampled immediately. If not, sampling should occur as soon as adequate volume has recovered.

Equipment Available

Monitoring well purging is accomplished by using in-place plumbing and dedicated pumps or, by using portable pumps/equipment when dedicated systems are not present. The equipment may consist of a variety of pumps, including peristaltic, large and small diameter turbine (electric submersible), bladder, centrifugal, gear-driven positive displacement, or other appropriate pumps. The use of any of these pumps is usually a function of the depth of the well being sampled and the amount of water that is to be removed during purging. Whenever the head difference between the sampling location and the water level is less than the limit of suction and the volume to be removed is reasonably small, a peristaltic pump should be used for purging. Appendix E of this SOP contains the operating instructions for all pumps commonly used during Branch ground water investigations.

Bailers may also be used for purging in appropriate situations, however, their use is discouraged. Bailers tend to disturb any sediment that may be present in the well, creating or increasing sample turbidity. If a bailer is used, it should be a closed-top Teflon® bailer.

7.2.2 Purging Techniques (Wells Without Plumbing or In-Place Pumps)

For permanently installed wells, the depth of water and depth of the well should be determined (if possible) before purging. Electrical water level indicators/well sounders can be used for this purpose. It is standard practice to mark the top of casing, providing a point of reference from which these measurements will be consistently made. Field investigators should look for these markings when taking these measurements. Extreme caution should be exercised during this procedure to prevent cross-contamination of the wells. This is a critical concern when samples for trace organic compounds or metals analyses are collected. At a minimum, the well sounding device should be cleaned by washing in a laboratory detergent solution, followed by rinses with tap water and analyte-free water. After cleaning, it should be placed in a clean plastic bag or wrapped in foil.

Purging with Pumps

When peristaltic pumps or centrifugal pumps are used, only the intake line is placed into the water column. The line placed into the water should be either standard-cleaned (see Appendix B) Teflon® tubing, for peristaltic pumps, or standard-cleaned stainless steel pipe attached to a hose for centrifugal pumps.

When submersible pumps (bladder, turbine, displacement, etc.) are used, the pump itself is lowered into the water column. The pump must be cleaned as specified in Appendix B.

Purging with Bailers

Standard-cleaned (Appendix B) closed-top Teflon® bailers with Teflon® leaders and new nylon rope are lowered into top of the water column, allowed to fill, and removed. It is critical that bailers be slowly and gently immersed into the top of the water column, particularly during final stages of purging, to minimize turbidity and disturbance of volatile organic constituents. The use of bailers for purging and sampling is discouraged because the correct technique is highly operator dependent.

Field Care of Purging Equipment

Regardless of which method is used for purging, new plastic sheeting should be placed on the ground surface around the well casing to prevent contamination of the pumps, hoses, ropes, etc., in the event they need to be placed on the ground during the purging or they accidentally come into contact with the ground surface. It is preferable that hoses used in purging that come into contact with the ground water be kept on a spool or contained in a plastic-lined tub, both during transporting and during field use, to further minimize contamination from the transporting vehicle or ground surface.

Purging Entire Water Column

The pump/hose assembly or bailer used in purging should be lowered into the top of the standing water column and not deep into the column. This is done so that the purging will "pull" water from the formation into the screened area of the well and up through the casing so that the entire static volume can be removed. If the pump is placed deep into the water column, the water above the pump may not be removed, and the subsequent samples, particularly if collected with a bailer, may not be representative of the ground water.

It is recommended that no more than three to five feet of hose be lowered into the water column. If the recovery rate of the well is faster than the pump rate and no observable draw down occurs, the pump should be raised until the intake is within one foot of the top of the water column for the duration of purging. If the pump rate exceeds the recovery rate of the well, the pump will have to be lowered, as needed, to accommodate the draw down. After the pump is removed from the well, all wetted portions of the hose and the pump should be cleaned as outlined in Appendix B of this SOP.

Careful consideration shall be given to using pumps to purge wells which are excessively contaminated with oily compounds, because it may be difficult to adequately decontaminate severely contaminated pumps under field conditions. When wells of this type are encountered, alternative purging methods, such as bailers, should be considered.

General Low Flow/Low Stress Method Preference

The device with the lowest pump or water removal rate and the least tendency to stress the well during purging should be selected for use. For example, if a bailer and a peristaltic pump both work in a given situation, the pump should be selected because it will greatly minimize turbidity, providing a higher quality sample (Section 7.2.4 contains a description of low flow purging and sampling with a peristaltic pump used in a temporary well). If a Fultz® pump or a Grundfos Redi-Flo2® could both be used, the Redi-Flo2® may be given preference because the speed can be controlled to provide a lower pump rate, thereby minimizing turbidity.

Low Flow/Low Volume Purging Techniques/Procedures

Alternatives to the low flow purging procedures exist and may be acceptable. The low flow/low volume purging is a procedure used to minimize purge water volumes. The pump intake is placed within the screened interval at the zone of sampling, preferably, the zone with the highest flow rate. Low flow rate purging is conducted after hydraulic conditions within the well have re-stabilized, usually within 24 to 48 hours. Flow rates should not exceed the recharge rate of the aquifer. This is monitored by measuring the top of the water column with a water level recorder or similar device while pumping. These techniques, however, are only acceptable under certain hydraulic conditions and are not considered standard procedures.

7.2.3 Purging Techniques - Wells with In-Place Plumbing

Wells with in-place plumbing are commonly found at municipal water treatment plants, industrial water supplies, private residences, etc. Many permanent monitoring wells at active facilities are also equipped with dedicated, in-place pumps. The objective of purging wells with in-place pumps is the same as with monitoring wells without in-place pumps, i.e., to ultimately collect a sample representative of the ground water. Among the types of wells identified in this section, two different approaches are necessary. The permanent monitoring wells with in-place pumps should, in all respects, be treated like the monitoring well without pumps. They generally are sampled only occasionally and require purging as described for wells without in-place pumps, i.e., 3 to 5 well volumes and stable parameters.

In the case of the other types of wells, however, not enough is generally known about the construction aspects of the wells to apply the same criteria as used for monitoring wells, i.e., 3 to 5 well volumes. The volume to be purged in these situations, therefore, depends on several factors: whether the pumps are running continuously or intermittently and whether or not any storage/pressure tanks are located between the sampling point and the pump. The following considerations and procedures should be followed when purging wells with in-place plumbing under the conditions described.

Continuously Running Pumps

If the pump runs more or less continuously, no purge (other than opening a valve and allowing it to flush for a few minutes) is necessary. If a storage tank is present, a spigot, valve or other sampling point should be located between the pump and the storage tank. If not, locate the valve closest to the tank. Measurements of pH, specific conductance, temperature, and turbidity are recorded at the time of sampling.

Intermittently Running Pumps

If the pump runs intermittently, it is necessary to determine, if possible, the volume to be purged, including storage/pressure tanks that are located prior to the sampling location. The pump should then be run continuously until the required volume has been purged. If construction characteristics are not known, best judgement should be used in establishing how long to run the pump prior to collecting the sample. Generally, under these conditions, 30 minutes will be adequate. Measurements of pH, specific conductance, temperature and turbidity should be made and recorded at intervals during the purge and the final measurements made at the time of sampling.

7.2.4 Purging Techniques - Temporary Monitoring Wells

Temporary ground water monitoring wells differ from permanent wells because temporary wells are installed in the ground water for immediate sample acquisition. Wells of this type may include standard well screen and riser placed in boreholes created by hand augering, power augering, or by drilling. They may also consist of a rigid rod and screen that is pushed, driven, or hammered into place to the desired sampling interval, such as the Direct Push Wellpoint®, the Geoprobe® and the Hydropunch®. As such, the efforts to remove several volumes of water to replace stagnant water do not necessarily apply in these situations, because generally, stagnant water is non-existent. It is important to note, however, that the longer a temporary well is in place and not sampled, the more appropriate it may be to apply, to the extent possible, standard permanent monitoring well purging criteria to it.

In cases where the temporary well is to be sampled immediately after installation, purging is conducted primarily to mitigate the impacts of installation. In most cases, temporary well installation procedures disturb the existing aquifer conditions, resulting primarily in increased turbidity. Therefore, the goal of purging is to reduce the turbidity and remove the volume of water in the area directly impacted by the installation procedure. Low turbidity samples in these types of wells are typically and routinely achieved by the use of low-flow purging and sampling techniques.

The following low-flow purging technique using peristaltic pumps has been used routinely to achieve acceptably low NTU values in a variety of temporary monitoring well applications.

In purging situations where the elevation of the top of the water column is no greater than approximately 25 feet below the pump head elevation, a peristaltic pump may be used to purge temporary wells. Enough tubing is deployed to reach the bottom of the temporary well screen. At the onset of purging, the tubing is slowly lowered to the bottom of the screen and is used to remove any formation material which may have entered the well screen during installation. This is critical to ensuring rapid achievement of low turbidity conditions. After the formation material is removed from the bottom of the screen, the tubing is slowly raised through the water column to near the top of the column. The tubing can be held at this level to determine if the pump is lowering the water level in the well. If not, secure the tubing at the surface to maintain this pumping level.

If the water column is lowered, and the pump is not variable speed, continue to lower the tubing as the water column is lowered. If a variable speed peristaltic pump is being used and draw down is observed on initiation of pumping, reduce the pump speed and attempt to match the draw down of the well. Sustained pumping at these slow rates will usually result in a relatively clear, low turbidity sample. If the draw down stabilizes, maintain that level, however, if it continues to lower, "chase" the water column until the well is evacuated. In this case, the recovered water column may be relatively free of turbidity and can be sampled. It may take several episodes of recovery to provide enough volume for a complete sample.

With many of the direct push sampling techniques, purging is not practical or possible, therefore, no purging is conducted. The sampling device is simply pushed to the desired depth and opened and the sample is collected and retrieved.

7.2.5 Investigation Derived Waste

Purging generates quantities of purge water or investigation derived waste (IDW), the disposition of which must be considered. What is appropriate for the disposition of the water is, in part, dependent on the nature of the investigation. If the IDW is generated at a RCRA facility, it will generally be contained and disposed on site in an on-site treatment facility. IDW generated during Superfund or other investigations may, at the discretion of the field project leader or the program manager (remedial project manager), be discharged to the ground, away from the well, or be containerized for later disposal or other appropriate action.

7.3 Sampling

Sampling is the process of obtaining, containerizing, and preserving the ground water sample after the purging process is complete. Non-dedicated pumps for sample collection generally should not be used. Many pumps are made of materials, such as brass, plastic, rubber, or other elastomer products which may cause chemical interferences with the sample. Their principle of operation may also render them unacceptable as a sample collection device. The pump may be turbine driven, which may release volatile organic constituents. It is recognized that there are situations, such as industrial or municipal supply wells or private residential wells, where a well may be equipped with a dedicated pump from which a sample would not normally be collected. Discretion should always be used in obtaining a sample.

7.3.1 Equipment Available

Because of the problems with most pumps described in the preceding paragraph, only three devices should be used to collect ground water samples from most wells. These are the peristaltic pump/vacuum jug assembly, a stainless steel and Teflon® bladder pump, and a closed-top, Teflon® bailer.

Other monitoring equipment used during sampling includes water level indicators, pH meters, thermometers, conductivity bridges, and nephelometers (turbidity meters).

7.3.2 Sampling Techniques - Wells With In-Place Plumbing

Samples should be collected following purging from a valve or cold water tap as near to the well as possible, preferably prior to any storage/pressure tanks that might be present. Remove any hose that may be present before sample collection and reduce the flow to a low level to minimize sample disturbance, particularly with respect to volatile organic constituents. Samples should be collected directly into the appropriate containers (see Standard Sample Containers, Appendix A). It may be necessary to use a secondary container, such as a clean 8 oz. sample jar or a stainless steel scoop, to obtain and transfer samples from spigots with low ground clearance. Also, refer to the Potable Water Supply discussion in Section 2.2. All measurements for pH, specific conductance, temperature, and turbidity should be recorded at the time of measurement.

7.3.3 Sampling Techniques - Wells without Plumbing

Following purging, samples should be collected using a peristaltic pump/vacuum jug assembly, a Teflon®/stainless steel bladder pump, or a closed-top Teflon® bailer. These techniques are described below.

Peristaltic pump/vacuum jug

The peristaltic pump/vacuum jug can be used for sample collection because it allows for sample collection without the sample coming in contact with the pump tubing. This is accomplished by placing a Teflon® transfer cap assembly onto the neck of a standard cleaned 4-liter (1-gallon) glass container. Teflon® tubing (¼-inch O.D.) connects the container to both the pump and the sample source. The pump creates a vacuum in the container, thereby drawing the sample into the container without it coming into contact with the pump tubing.

Samples for volatile organic compound analysis should be collected using a bailer or by filling the Teflon® tube, by one of two methods, and allowing it to drain into the sample vials. The tubing can be momentarily attached to the pump to fill the tube with water. After the initial water is discharged through the pump head, the tubing is quickly removed from the pump and a gloved thumb placed on the tubing to stop the water from draining out. The tubing is then removed from the well and the water allowed to either gravity drain or be reversed, by the pump, into the sample vials. (Note: When reversing the pump, make sure the discharge tubing is not submerged in purge water. This will prevent introducing potentially cross-contaminated purge water into the sample.) Alternatively, the tubing can be lowered into the well the desired depth and a gloved thumb placed over the end of the tubing. This method will capture the water contained in the tubing. It can then be removed from the well and the water collected by draining the contents of the tubing into the sample vials. Under no circumstances should the sample for volatile organic compound analysis be collected from the content of any other previously filled container. All equipment should be cleaned using the procedures described in Appendix B. Also, refer to the Potable Water Supply discussion, Section 2.2, for additional information.

When sampling for metals only, it is also permissible to collect the sample directly from the pump discharge tubing after an adequate purge has been demonstrated. When collecting samples in this manner there are several considerations to be aware of. The pump head tubing (silastic, etc,) must be changed after each well and a rinsate blank must be collected of a representative piece of the pump head tubing (only one blank per investigation). Also, precautions must be taken to ensure that the end of the discharge tubing is not allowed to touch the ground or other surface to ensure the integrity of the sample collected in this manner.

Bladder Pumps

After purging has been accomplished with a bladder pump, the sample is obtained directly from the pump discharge. If the discharge rate of the pump, during purging, is too great, so as to make sample collection difficult, care should be taken to reduce the discharge rate at the onset of actual sample collection. This is necessary to minimize sample disturbance, particularly with respect to samples collected for volatile organic compounds analysis.

Bailers

When bailing, new plastic sheeting should be placed on the ground around each well to provide a clean working area. New nylon rope should be attached to the bailer via a Teflon® coated stainless steel wire. This coated wire is semi-permanently attached to the bailer and is decontaminated for reuse as the bailer is cleaned. The bailer should be gently immersed in the top of the water column until just filled. At this point, the bailer should be carefully removed and the contents emptied into the appropriate sample containers.

7.3.4 Sample Preservation

Immediately after collection, all samples requiring preservation must be preserved with the appropriate preservative. Consult Appendix A for the correct preservative for the particular analytes of interest. All samples preserved using a pH adjustment (except VOCs) must be checked, using pH strips, to ensure that they were adequately preserved. This is done by pouring a small volume of sample over the strip. Do not place the strip in the sample.

7.3.5 Special Sample Collection Procedures

<u>Trace Organic Compounds and Metals</u>

Special sample handling procedures should be instituted when trace contaminant samples are being collected. All sampling equipment, including pumps, bailers, water level measurement equipment, etc., which comes into contact with the water in the well must be cleaned in accordance with the cleaning procedures described in Appendix B. Pumps should not be used for sampling, unless the interior and exterior portions of the pump and the discharge hoses are thoroughly cleaned. Blank samples should be collected to determine the adequacy of cleaning prior to collection of any sample using a pump.

<u>Order of Sampling with Respect to Analytes</u>

In many situations when sampling permanent or temporary monitoring wells, an adequate purge, with respect to turbidity, is often difficult to achieve. Removal and insertion of equipment after the purge and prior to actual sampling may negate the low turbidities achieved during purging and elevate turbidity back to unacceptable levels. For this reason, it is important that special efforts be used to minimize any disturbance of the water column after purging and to collect the aliquot for metals first.

<u>Filtering</u>

As a standard practice, ground water samples will not be filtered for routine analysis. Filtering will usually only be performed to determine the fraction of major ions and trace metals passing the filter and used for flow system analysis and for the purpose of geochemical speciation modeling. Filtration is not allowed to correct for improperly designed or constructed monitoring wells, inappropriate sampling methods, or poor sampling technique.

When samples are collected for routine analyses and are filtered, such as under conditions of excessive turbidity, both filtered and non-filtered samples will be submitted for analyses. Samples for organic compounds analysis should not be filtered. Prior to filtration of the ground water sample for any reason other than geochemical speciation modeling, the following criteria must be demonstrated to justify the use of filtered samples for inorganic analysis:

1. The monitoring wells, whether temporary or permanent, have been constructed and developed in accordance with Section 6.

2. The ground water samples were collected using sampling techniques in accordance with this section, and the ground water samples were analyzed in accordance with US-EPA approved methods.

3. Efforts have been undertaken to minimize any persistent sample turbidity problems. These efforts may consist of the following:

    - Redevelopment or re-installation of permanent ground water monitoring wells.

    - Implementation of low flow/low stress purging and sampling techniques.

4. Turbidity measurements should be taken during purging and sampling to demonstrate stabilization or lack thereof. These measurements should be documented in the field notes.

If the ground water sample appears to have either a chemically-induced elevated turbidity, such as would occur with precipitate formation, or a naturally elevated colloid or fine, particulate-related turbidity, filtration will not be allowed.

If filtration is necessary for purposes of geochemical modeling or other **pre-approved** cases, the following procedures are suggested:

1. Accomplish in-line filtration through the use of disposable, high capacity filter cartridges (barrel-type) or membrane filters in an in-line filter apparatus. The high capacity, barrel-type filter is preferred due to the higher surface area associated with this configuration. If a membrane filter is utilized, a minimum diameter of 142 mm is suggested.

2. Use a 5 µm pore-size filter for the purpose of determining the colloidal constituent concentrations. A 0.1 µm pore-size filter should be used to remove most non-dissolved particles.

3. Rinse the cartridge or barrel-type filter with 500 milliliters of the solute (ground water to be sampled) prior to collection of sample. If a membrane filter is used, rinse with 100 milliliters of solute prior to sample collection.

Potential differences could result from variations in filtration procedures used to process water samples for the determination of trace element concentrations. A number of factors associated with filtration can substantially alter "dissolved" trace element concentrations; these include filter pore size, filter type, filter diameter, filtration method, volume of sample processed, suspended sediment concentration, suspended sediment grain-size distribution, concentration of colloids and colloidally-associated trace elements, and concentration of organic matter. Therefore, consistency is critical in the comparison of short-term and long-term results. Further guidance on filtration may be obtained from the following: 1) Metals in Ground Water: Sampling Artifacts and Reproducibility (3); 2) Filtration of Ground Water Samples for Metals Analysis (4); and 3) Ground Water Sampling - A Workshop Summary (5).

Bacterial Sampling

Whenever wells (normally potable wells) are sampled for bacteriological parameters, care must be taken to ensure the sterility of all sampling equipment and all other equipment entering the well. Further information regarding bacteriological sampling is available in the following: 1) Sampling for Organic Chemicals and Microorganisms in the Subsurface (6); 2) Handbook for Evaluating Water Bacteriological Laboratories (7); and 3) Microbiological Methods for Monitoring the Environment, Water and Wastes (8).

7.3.6 Specific Sampling Equipment Quality Assurance Techniques

All equipment used to collect ground water samples shall be cleaned as outlined in Appendix B and repaired, if necessary, before being stored at the conclusion of field studies. Cleaning procedures utilized in the field (Appendix B), or field repairs shall be thoroughly documented in field records.

7.3.7 Auxiliary Data Collection

During ground water sample collection, it is important to record a variety of ground water related data. Included in the category of auxiliary data are water level measurements, well volume determinations, pumping rates during purging, and occasionally, drillers or boring logs. This information should be documented in the field records. Well volume determinations are described in Section 7.2.1.

Water Level Measurements

Water table measurements from the top of the well casings (referenced to National Geodetic Vertical Datum) in permanent wells, and ground surface elevations in temporary wells should be made to assist in determining the general direction of ground water flow and gradient. The methodology to be used to determine well water levels are given in Section 15.5. Tracer dyes and radioactive and thermal detection methods can be used to determine direction and velocities of flow (9). Also, a study of the general topography and drainage patterns will generally indicate direction of ground water flow.

The ground surface elevation and top of casing elevation at the wells should be determined by standard engineering survey practices as outlined in Section 15.

Well Pumping Rate - Bucket/Stop Watch Method

The pumping rate for a pump can be determined by collecting the discharge from the pump in a bucket of known volume and timing how long it takes to fill the bucket. The pumping rate should be in gallons per minute. This method shall be used primarily with pumps with a constant pump rate, such as gasoline-powered or electric submersible pumps. Care should be taken when using this method with some battery-powered pumps. As the batteries' charge decreases, the pump rate also decreases so that pumping rate calculations using initial, high pump rates may be erroneously high. If this method is used with battery-powered pumps, the rate should be re-checked frequently to ensure accuracy of the pumping rate calculations.

7.4 References

1. US EPA., RCRA Ground-Water Monitoring: Draft Technical Guidance, November 1992, Office of Solid Waste, EPA/530-R-93-001.

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3. Puls, Robert W., Don A. Clark, and Bert Bledsoe. Metals in Ground Water: Sampling Artifacts and Reproducibility. *Hazardous Waste and Hazardous Materials* 9(2): 149-162 (1992).

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7. Handbook for Evaluating Water Bacteriological Laboratories, US EPA, ORD, Municipal Environmental Research Laboratory, Cincinnati, Ohio, 1975.

8. Microbiological Methods for Monitoring the Environment, Water and Wastes, US EPA, ORD, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio, 1978.

9. "Groundwater", Section 18, USDA-SCS National Engineering Handbook, United States Department of Agriculture, Soil Conservation Service, 1978.

SECTION 8
SAMPLING OF POTABLE WATER SUPPLIES

PERFORMANCE OBJECTIVES:

- To collect a sample representative of the drinking water supply.
- To reduce the bias of system related variables (pumps, piping, holding tanks, etc.).

8.1 Introduction

The same sampling techniques used for wastewater, ground water, surface water, etc., (including thorough documentation of location, date, time, etc.) are to be used during potable water supply sampling. There are certain additional procedures which apply.

8.2 Sampling Site Selection

The following should be considered when choosing the location to collect a potable water sample:

- Taps selected for sample collection should be supplied with water from a service pipe connected directly to a water main in the segment of interest.
- Whenever possible, choose the tap closest to the water source, and prior to the water lines entering the residence, office, building, etc., and also prior to any holding or pressurization tanks.
- The sampling tap must be protected from exterior contamination associated with being too close to a sink bottom or to the ground. Contaminated water or soil from the faucet exterior may enter the bottle during the collection procedure since it is difficult to place a bottle under a low tap without grazing the neck interior against the outside faucet surface. If the tap is too close to the ground for direct collection into the appropriate container, it is acceptable to use a smaller (clean) container to transfer sample to a larger container. The smaller container should be made of glass or stainless steel.
- Leaking taps that allow water to discharge from around the valve stem handle and down the outside of the faucet, or taps in which water tends to run up on the outside of the lip, are to be avoided as sampling locations.
- Disconnect any hoses, filters, or aerators attached to the tap before sampling. These devices can harbor a bacterial population if they are not routinely cleaned or replaced when worn or cracked.
- Taps where the water flow is not constant should be avoided because temporary fluctuation in line pressure may cause clumps of microbial growth that are lodged in a pipe section or faucet connection to break loose. A smooth flowing water stream at moderate pressure without splashing should be used. The sample should be collected without changing the water flow. It may be appropriate to reduce the flow for the volatile organic compounds aliquot to minimize sample agitation.

Occasionally, samples are collected to determine the contribution of system related variables (e.g., transmission pipes, water coolers, water heaters, holding tanks, pressurization tanks, etc.) to the quality of potable water supplies. In these cases, it may be necessary to insure that the water source has not been used for a specific time interval (e.g., over a weekend or a three- or four-day holiday period). Sample collection may consist of collecting a sample of the initial flush, collecting a sample after several minutes, and collecting another sample after the system being investigated has been completely purged.

When sampling for bacterial content, the sample container should not be rinsed before use due to possible contamination of the sample container or removal of the thiosulfate dechlorinating agent (if used). When filling any sample container, care should be taken that no splashing drops of water from the ground or sink do not enter into either the bottle or cap.

When sampling at a water treatment plant, samples are often collected from the raw water supply and the treated water after chlorination.

Obtain the name(s) of the resident or water supply owner/operator, the resident's exact mailing address, and the resident's home and work telephone numbers. The information is required so that the residents or water supply owner/operators can be informed of the results of the sampling program (See Section 2.2).

Sampling Technique (1)

The following procedures should be followed when collecting samples from potable water supplies:

1. Ideally, the sample should be collected from a tap or spigot located at or near the well head or pump house and before the water supply is introduced into any storage tanks or treatment units. If the sample must be collected at a point in the water line beyond a pressurization or holding tank, a sufficient volume of water should be purged to provide a complete exchange of fresh water into the tank and at the location where the sample is collected. If the sample is collected from a tap or spigot located just before a storage tank, spigots located inside the building or structure should be turned on to prevent any backflow from the storage tank to the sample tap or spigot. It is generally advisable to open several taps during the purge to ensure a rapid and complete exchange of water in the tanks.

2. Purge the system for at least 15 minutes when possible. After purging for several minutes, measure the turbidity, pH, specific conductivity, and temperature of the water. Continue to monitor these parameters until three consistent readings are obtained. If possible, obtain three consistent readings after the 15 minute purge.

3. After three consistent readings have been obtained, samples may be collected.

8.3 Reference

1. Sampling for Organic Chemicals and Microorganisms in the Subsurface, United States Environmental Protection Agency, EPA-600/2-77-176, 1977.

SECTION 9
WASTEWATER SAMPLING

SECTION OBJECTIVE:

- To provide guidance for the proper collection of wastewater samples.

9.1 Introduction

The variety of conditions at different sampling locations require that considerable judgment be exercised regarding the methodologies and procedures for the collection of representative samples of wastewater. Each sampling location warrants attention commensurate with its complexity. There are, however, basic rules and precautions generally applicable to sample collection. Acceptable procedures are generally those outlined in the NPDES Compliance Inspection Manual (1). Some important considerations for obtaining a representative wastewater sample include:

- The sample should be collected where the wastewater is well mixed. Therefore, the sample should be collected near the center of the flow channel, at approximately 40 to 60 percent of the water depth, where the turbulence is at a maximum and the possibility of solids settling is minimized. Skimming the water surface or dragging the channel bottom should be avoided. However, allowances should be made for fluctuations in water depth due to flow variations.

- In sampling from wide conduits, cross-sectional sampling should be considered. Rhodamine WT dye (See Section 15.7 for references) may be used as an aid in determining the most representative sampling locations.

- If manual compositing is employed, the individual sample portions must be thoroughly mixed before pouring the individual aliquots into the composite container. For manual composite sampling, the individual sample aliquots should be preserved at the time of sample collection (2).

- When collecting samples or installing sampling equipment, field investigators should always wear a new pair of the appropriate protective gloves (disposable latex gloves, rubber gloves, etc.) to prevent contamination of the sample and reduce exposure to hazardous substances.

9.2 Site Selection

Where applicable, wastewater samples should be collected at the location specified in the NPDES permit (if the source has a permit). In some instances the sampling location specified in the permit, or the location chosen by the permittee, may not be acceptable for the collection of a representative wastewater sample. In such instances, the investigator is not limited by permit specifications and may collect a sample at a more representative location. When a conflict exists between the permittee and the regulatory agency regarding the most representative sampling location, both sites should be sampled, and the reason for the conflict should be noted in the field notes and the inspection or study report. Recommendations and reasons for a change in sampling locations should be given to the appropriate permitting authority.

9.2.1 Influent

Influent wastewaters are preferably sampled at locations of highly turbulent flow in order to ensure good mixing; however, in many instances the most desirable location is not accessible. Preferable influent wastewater sampling locations include: 1) the upflow siphon following a comminutor (in absence of grit chamber); 2) the upflow distribution box following pumping from main plant wet well; 3) aerated grit chamber; 4) flume throat; 5) pump wet well when the pump is operating; or 6) downstream of preliminary screening. When possible, influent samples should be collected upstream from sidestream returns.

9.2.2 Effluent

Effluent samples should be collected at the site specified in the permit, or if no site is specified in the permit, at the most representative site downstream from all entering wastewater streams prior to discharge into the receiving waters. If a conflict exists between the permittee and inspector regarding the source being sampled or the location of the most representative site, follow the procedures previously described under "Site Selection".

9.2.3 Pond and Lagoon Sampling

Generally, composite effluent wastewater samples should be collected from ponds and lagoons. Even if the ponds or lagoons have long retention times, composite sampling is necessary because of the tendency of ponds and lagoons to have flow paths that short circuit which changes the design detention time.

9.3 Sample Types

For NPDES sampling, two types of sampling techniques are used: grab and composite. For these procedures, the NPDES permit specifies the appropriate sample type. A complete description of all NPDES sampling procedures and techniques is presented in the NPDES Compliance Inspection Manual (1).

9.3.1 Grab Samples

Grab samples consist of either a single discreet sample or individual samples collected over a period of time not to exceed 15 minutes. The grab sample should be representative of the wastewater conditions at the time of sample collection. The sample volume depends on the type and number of analyses to be performed.

9.3.2 Composite Samples

Composite samples are collected over time, either by continuous sampling or by mixing discrete samples. A composite sample represents the average wastewater characteristics during the compositing period. Various methods for compositing are available and are based on either time or flow proportioning. The choice of a flow proportional or time composite sampling scheme depends on the permit requirements, variability of the wastewater flow or concentration of pollutants, equipment availability, and sampling location. The investigator must know each of these criteria before a sampling program can be initiated. Generally, a time composite is acceptable. However in enforcement cases where strict adherence to permit requirements are necessary or if an investigator knows or suspects that there is significant variability in the wastewater flow, a flow proportional sample is preferable .

A time composite sample consists of equal volume discrete sample aliquots collected at constant time intervals into one container. A time composite sample can be collected either manually or with an automatic sampler.

A flow proportional composite sample can be collected using one of two methods. One method consists of collecting a constant sample volume at varying time intervals proportional to the wastewater flow. For the other method, the sample is collected by varying the volume of each individual aliquot proportional to the flow, while maintaining a constant time interval between the aliquots. Prior to collecting flow proportional samples, the facility's flow measuring system should be examined for proper installation and accuracy (see Section 18). If the facility's primary flow measuring device does not meet standard conditions (see Section 18), or is in an unsafe or inaccessible location, then the investigator should collect time composite samples. If the flow measurement system is acceptable, samples should be collected using the appropriate flow proportioning methods.

Flow proportional samples can be collected with an automatic sampler and a compatible flow measuring device, with a flow chart and an automatic sampler capable of collecting discrete samples, or manually by compositing individual grab samples by volume versus flow chart readings.

9.4 Use of Automatic Samplers

9.4.1 Introduction

Automatic samplers may be used to collect composite or grab samples when several aliquots are to be collected at frequent intervals or when a continuous sample is required. For composite sampling applications, the automatic samplers may be used to collect time composite or flow proportional samples. In the flow proportional mode, the samplers are activated and paced by a compatible flow meter. Flow proportional samples can also be collected using an automatic sampler equipped with multiple containers and manually compositing the individual sample portions proportional to the flow (1).

Automatic samplers must meet the following requirements:

- Sampling equipment must be properly cleaned to avoid cross-contamination which could result from prior use (see Appendix B for cleaning procedures).
- No plastic or metal parts of the sampler shall come in contact with the water or wastewater stream when parameters to be analyzed could be impacted by these materials.
- The automatic sampler must be capable of providing adequate refrigeration during the sampling period. This can be accomplished in the field by using ice.
- The automatic sampler must be able to collect a large enough sample for all parameter analyses.
- The individual sample aliquot must be at least 100 mls.
- The automatic sampler should be capable of providing a lift of at least 20 feet and the sample volume should be adjustable since the volume is a function of the pumping head.
- The pumping velocity must be at least 2 ft/sec to transport solids and not allow solids to settle.
- The intake line leading to the pump must be purged before each sample is collected.
- The minimum inside diameter of the intake line should be 1/4 inch.
- An adequate power source should be available to operate the sampler for the time required to complete the project. Facility electrical outlets may be used if available.

- Facility automatic samplers should only be used if 1) field conditions do not allow for the installation of EPA sampling equipment, and 2) the facility sampling equipment meets all of the requirements of this SOP.

Specific operating instructions, capabilities, capacities, and other pertinent information for automatic samplers are included in the respective operating manuals.

9.4.2 Conventional Sampling (Inorganic Parameters)

Conventional sampling includes all inorganic parameters (e.g., BOD_5, TSS, COD, nutrients) that can be collected using an automatic sampler.

New tubing (Silastic®, or equal, in the pump and either Teflon® or Tygon®, or equal, in the sample train) will be used for each sampler installation.

Installation procedures include cutting the proper length of tubing, positioning it in the wastewater stream, and sampler programming. Protective gloves should be worn to reduce exposure and to maintain the integrity of the sample.

For a time composite sample, the sampler should be programmed to collect at least 100-milliliter aliquots at a frequency that provides a representative sample and enough sample volume to conduct all required analyses.

For a flow proportional sample, the sampler should be programmed to collect a minimum of 100 milliliters for each sample aliquot with the interval predetermined based on the flow of the monitored stream.

At the end of the compositing period, the sample collected should be properly mixed and transferred into the respective containers, followed by immediate preservation, if required. For routine inspections, the permittee should be offered a split sample.

9.4.3 Metals

When an automatic sampler is used for collecting samples for metals analyses, the entire sampler collection system should be rinsed with organic/analyte free water, and an equipment blank should be collected. Approximately one-half gallon of rinse water should be pumped through the sample tubing into the composite container and discarded. Nitric acid must be added to the metals blank container for proper preservation. The sampler may then be positioned in the appropriate location and the sampler program initiated.

If the sampler tubing is attached to a metal conduit pipe, the sampler intake tubing should be carefully installed upstream and away from the conduit to prevent metals contamination. This can be accomplished by clamping the tubing upstream of the conduit using laboratory clamps and wrapping the submerged portion of conduit pipe with a protective barrier (e.g., duct tape).

9.4.4 Extractable Organic Compounds, Pesticides, and PCBs

When an automatic sampler is used for collecting samples for the analyses of extractable organic compounds, pesticides, and/or PCBs, the installation procedures include cutting the proper length of new Teflon® tubing, rinsing of the entire sampler collection system with organic/analyte free water, and collection of appropriate blanks for organic compounds analysis. For the organic/analyte free water rinse, approximately one-half gallons is initially pumped into the composite sample container and discarded. An additional one and one-half gallons (approximate) are then pumped into the composite sample container for distribution into the appropriate blank container. Finally the collection tubing should be positioned in the wastewater stream and the sampler programmed and initiated.

9.4.5 Automatic Sampler Security

Field investigators should take whatever steps are necessary to prevent tampering with EPA equipment. A lock or custody seal may be placed on the sampler to detect tampering. However, this does not prevent tampering with the sample collection tubing. If necessary, seals may be placed on the sampling pole and tubing line to further reduce tampering possibilities.

9.4.6 Automatic Sampler Maintenance, Calibration, and Quality Control

To ensure proper operation of automatic samplers, and thus the collection of representative samples, the following maintenance and calibration procedures should be used and any deviations should be documented in the field log book.

Prior to being used, the sampler operation should be checked to ensure proper operation by Field Equipment Center personnel. This includes operation (forward, reverse, automatic) of at least one purge-pump-purge cycle; checking desiccant and replacing if necessary; checking the 12-volt batteries to be used with the sampler; and repairing any item if necessary.

During each field trip, prior to initiating the automatic sampler, the rinse and purge-pump-purge cycle shall be checked at least once. The pumping volume should be checked at least twice using a graduated cylinder or other calibrated container prior to initiating the sampler. For flow proportional sampling, the flow meter that activates the sampler should be checked to insure that it operates properly.

Upon returning from a field trip, the structural integrity of the sampler should be examined and repaired, if necessary. The desiccant will be checked and replaced if appropriate. The operation (forward, reverse, automatic, etc.) will be checked and required repairs will be made and documented. The sampler will then be cleaned as outlined in Appendix B.

The automatic sampler should be checked against the manufacturer's specifications and documented whenever one or more of the sampler functions appears to be operating improperly.

9.5 Manual Sampling

Manual sampling is normally used for collecting grab samples and/or for immediate in-situ field analyses. However, it can also be used in lieu of automatic equipment over extended periods of time for composite sampling, especially when it is necessary to evaluate unusual waste stream conditions.

The best method to manually collect a sample is to use the actual sample container which will be used to transport the sample to the laboratory. This eliminates the possibility of contaminating the sample with intermediate collection containers. If the water or wastewater stream cannot be physically reached by the sampling personnel or it is not safe to reach for the sample, an intermediate collection container may be used, from which the sample can be redistributed to other containers. If this is done, however, the container used to collect the sample must be properly cleaned (Appendix B) and must be made of a material that meets the requirements of the parameter(s) being investigated. Samples for oil and grease, bacteria, phenols, volatile organic compounds, and sulfides analyses must always be collected directly into the sample container.

In some cases it may be best to use a pump, either power or hand operated, to withdraw a sample from the water or wastewater stream. If a pump is used, it is imperative that all components of the pump that come in contact with the sample are properly cleaned (Appendix B) to ensure the integrity of the sample.

In general, samples are manually collected by first selecting a location in the wastestream that is well mixed (Section 9.1) then dipping the container in the water or wastewater stream so the mouth of the container faces upstream. The container should not be overfilled if preservatives are present in the container.

9.6 Special Sample Collection Procedures

9.6.1 Organic Compounds and Metals

Trace organic compounds and metals detection limits are usually in the parts per billion or parts per trillion range, so extreme care must be exercised to ensure sample integrity.

All containers, composite bottles, tubing, etc, used for sample collection for trace organic compounds and metals analyses should be prepared as described in Appendix B.

When possible, the sample should be collected directly into the appropriate sample container. If the material to be sampled cannot be physically reached, an intermediate collection device may be used. This should be a Teflon®, glass, or stainless steel vessel on a pole or rope or Teflon® tubing via a peristaltic type pump and a Teflon® vacuum container attachment which converts a sample container into a vacuum container. The device which is used should be cleaned as described in Appendix B.

9.6.2 Bacteriological

Samples for bacteriological analyses must always be collected directly into the prepared glass or plastic sample container. The sample container should be kept unopened until it is to be filled. When the cap is removed, care should be taken not to contaminate the cap or the inside of the bottle. The bottle should be held near the base and filled to within about one inch of the top without rinsing and recapped immediately. During sample collection, the sample container should be plunged with the neck partially below the surface and slightly upward. The mouth should be directed against the current. Appendix A lists preservation procedures and holding times.

When the sample container must be lowered into the waste stream, either because of safety or impracticality (manhole, slippery effluent area, etc.), care must be taken to avoid contamination.

9.6.3 Immiscible Liquids/Oil and Grease

Oil and grease may be present in wastewater as a surface film, an emulsion, a solution, or as a combination of these forms. Since it is very difficult to collect a representative sample for oil and grease analysis, the inspector must carefully evaluate the location of the sampling location. The most desirable sampling location is the area of greatest mixing. Quiescent areas should be avoided. The sample container should be plunged into the wastewater using a swooping motion with the mouth facing upstream. Care should be taken to ensure that the bottle does not over fill during sample collection.

Because losses of oil and grease will occur on sampling equipment, an automatic sampler should not be used to collect samples for oil and grease analysis. Individual portions collected at prescribed time intervals must be analyzed separately to obtain the average concentrations over an extended period.

9.6.4 Volatile Organic Compounds

Samples to be analyzed for volatile organic compounds (VOCs) should be collected in 40-ml septum vials with screw caps with a Teflon® lined silicone disk in the cap to prevent contamination of the sample by the cap. The disks should be placed in the caps (Teflon® side to be in contact with the sample) in the laboratory prior to the beginning of the sampling program.

When sampling for VOCs, triplicate samples should always be collected from each location. The investigator should determine if the water to be sampled contains chlorine. If the water contains no chlorine, three pre-preserved 40-ml vials should be filled with the sample. The samples may be held for up to 14 days before analysis. When preservation is not feasible, samples can be held up to 7 days before analysis.

If the water contains chlorine, fill an 8-ounce sampling container with 2 drops of a 25% ascorbic acid solution and the water sample. Cap and mix thoroughly but gently by swirling to eliminate residual chlorine. Transfer the sample to three pre-preserved 40-ml vials (see Appendix A). The ascorbic acid and preservative must be added in this order and in two separate steps.

The 40-ml vials should be completely filled to prevent volatilization, and extreme caution should be exercised when filling each vial to prevent any turbulence which could also produce volatilization. The sample should be carefully poured down the side of the vial to minimize turbulence. As a rule, it is best to gently pour the last few drops into the vial so that surface tension holds the water in a "convex meniscus." The cap is then applied and some overflow is lost, but air space in the bottle is eliminated. After capping, turn the bottle over and tap it to check for bubbles; if any are present, repeat the procedure using a new 40-ml vial.

9.7 Special Process Control Samples and Tests

During diagnostic evaluations, process control tests may be conducted to evaluate and troubleshoot the performance of the biological treatment processes of a municipal or industrial wastewater treatment facility. The EPA Activated Sludge Process Control Testing handbook is the standard reference for activated sludge process control testing (3). The manual includes a complete description of the step-by-step procedures for each test and the interpretation of the results. The six basic activated sludge process control tests are:

- Sludge settleability (settlometer).
- Centrifuge spins.
- Aeration basin DO profiles.
- Oxygen uptake rate (OUR) measurements.
- Mixed liquor microscopic examinations.
- Sludge blanket depth (SBD) measurements.

Additional references are available that provide a more comprehensive evaluation of the methods used to conduct a diagnostic evaluation (4, 5, 7, and 8,). Completion of the Sacramento Operation of Wastewater Treatment Plants course is highly recommended for all personnel prior to serving as the project leader on a Diagnostic Evaluation (6).

9.8 Supplementary Data Collection

While conducting wastewater sampling, the following information will also be obtained (if applicable):

- Field measurements -- pH, dissolved oxygen, conductivity, and temperature (see Section 16 for standard field analytical techniques).

- Flows associated with the samples collected -- continuous flows with composite samples and instantaneous flows with grab samples (Section 18).

- Diagrams and/or written descriptions of the wastewater treatment systems (if available).

- Photographs of pertinent wastewater associated equipment, such as flow measuring devices, treatment units, etc. (keep photolog as specified in section 3.2).

- Process control information on the wastewater treatment process (if applicable).

- Completion of applicable forms required during specific investigations.

All observations, measurements, diagrams, etc., will be entered in bound field logbooks or attached thereto (where applicable as specified in Section 3.5).

9.9 Sample Preservation

All sample collection and preservation procedures should comply with the requirements outlined in 40 CFR, Part 136.3 (e), Table 11 (9).

9.10 References

1. NPDES Compliance Inspection Manual, United States Environmental Protection Agency, September 1994.

2. Code of Federal Regulations, 40 CFR, Part 136.3, Table II, (latest issue).

3. US-EPA, "Activated Sludge Process Control Testing", ESD, Water Compliance Unit, Athens, GA., October 2000.

4. US-EPA, "Process Control Manual: Aerobic Biological Treatment Facilities MD-14", EPA 430/09-77-006, Office of Water, Washington, D.C., 1977.

5. Metcalf and Eddy, Inc., "Wastewater Engineering: Treatment, Disposal, Reuse", McGraw-Hill Book Co., New York, NY, 1991.

6. California State University - Sacramento, "Operation of Wastewater Treatment Plants - Volumes I, II, III", Sacramento, California.

7. "Operation Of Municipal Wastewater Treatment Plants", Manual Of Practice No.11, Fifth Edition, Water Environment Federation 1996.

8. "Design Of Municipal Wastewater Treatment Plants", Manual Of Practice No. 8, Fourth Edition, Water Environment Federation and ASCE, 1998.

9. 40 CFR, Part 136 (e), Table 11.

SECTION 10
SURFACE WATER SAMPLING

PERFORMANCE OBJECTIVE:

- To collect a representative sample of the surface water of interest.

10.1 Introduction

Surface water sampling techniques and equipment are designed to minimize effects on the chemical and physical integrity of the sample. If the guidance provided in this section is followed, a representative sample of the surface water should be obtained.

The physical location of the investigator when collecting a sample may dictate the equipment to be used. If surface water samples are required, direct dipping of the sample container into the stream is desirable. This is possible, however, only from a small boat, a pier, etc., or by wading in the stream. Wading, however, may cause the re-suspension of bottom deposits and bias the sample. Wading is acceptable if the stream has a noticeable current (is not impounded), and the samples are collected while facing upstream. If the stream is too deep to wade, or if the sample must be collected from more than one water depth, or the sample must be collected from a bridge, etc., supplemental sampling equipment must be used.

10.2 Surface Water Sampling Equipment

10.2.1 Dipping Using Sample Container

A sample may be collected directly into the sample container when the surface water source is accessible by wading or other means. The sampler should face upstream and collect the sample without disturbing the sediment. The surface water sample should always be collected prior to the collection of a sediment sample at the same location. The sampler should be careful not to displace the preservative from a pre-preserved sample container such as the 40-ml VOC vial.

10.2.2 Scoops

Stainless steel scoops are useful for reaching out into a body of water to collect a surface water sample. The scoop may be used directly to collect and transfer a surface water sample to the sample container, or it may be attached to an extension in order to access the selected sampling location. The scoop is one of the most versatile sampling tools available to the field investigator.

10.2.3 Peristaltic Pumps

Another device that can be effectively used to sample a water column, such as a shallow pond, is the peristaltic pump/vacuum jug system. The use of a metal conduit to which the tubing is attached, allows for the collection of a vertical sample (to about a 25 foot depth) which is representative of the water column. Commercially available pumps vary in size and capability, with some being designed specifically for the simultaneous collection of multiple water samples.

10.2.4 Discrete Depth Samplers

When discrete samples are desired from a specific depth, and the parameters to be measured do not require a Teflon® coated sampler, a standard Kemmerer or Van Dorn sampler may be used. The Kemmerer sampler is a brass cylinder with rubber stoppers that leave the ends of the sampler open while being lowered in a vertical position, thus allowing free passage of water through the cylinder. The Van Dorn sampler is plastic and is lowered in a horizontal position. In each case, a messenger is sent down a rope when the sampler is at the designated depth, to cause the stoppers to close the cylinder, which is then raised. Water is removed through a valve to fill respective sample containers. With a rubber tube attached to the valve, dissolved oxygen sample bottles can be properly filled by allowing an overflow of the water being collected. With multiple depth samples, care should be taken not to stir up the bottom sediment and thus bias the sample.

When metals and organic compounds parameters are of concern, then a double check valve, stainless steel bailer or Kemmerer sampler should be used to collect the sample.

10.2.5 Bailers

Teflon® bailers may also be used for surface water sampling, if the study objectives do not necessitate a sample from a discrete interval of the water column. A closed top bailer with a bottom check-valve is sufficient for many studies. As the bailer is lowered through the water column, water is continually displaced through the bailer until the desired depth is reached, at which point the bailer is retrieved. This technique may not be successful where strong currents are found.

10.2.6 Buckets

A plastic bucket can be used to collect samples for in-situ analyses, e.g., pH, temperature and conductivity. However, the bucket should be rinsed twice with the sample water prior to collection of the sample.

SECTION 11
SEDIMENT SAMPLING

PERFORMANCE OBJECTIVE:

- To collect a representative sample of sediment from a surface water body.

11.1 Introduction

Sampling techniques and equipment are designed to minimize effects on the chemical and physical integrity of the sample. If the guidance in this section is followed, a representative sample of the sediment should be obtained.

The physical location of the investigator when collecting a sample may dictate the equipment to be used. Wading is the preferred method for reaching the sampling location, particularly if the stream has a noticeable current (is not impounded). However, wading may disrupt bottom sediments causing biased results. If the stream is too deep to wade, the sediment sample may be collected from a boat or from a bridge.

To collect a sediment sample from a water body, a variety of methods can be used:

- Dredges (Peterson, Eckman, Ponar),
- Coring (tubes, augers)
- Scoops (BMH-60, standard scoop) and spoons
- Vibracore® (Electronic Vibratory Core Tube Driver)

Regardless of the method used, precautions should be taken to insure that the sample collected is representative of the water body. These methods are discussed in the following paragraphs.

11.2 Sediment Sampling Equipment

11.2.1 Scoops and Spoons

If the surface water body is wadeable, the easiest way to collect a sediment sample is by using a stainless steel scoop or spoon. The sampling method is accomplished by wading into the surface water body and while facing upstream (into the current), scooping the sample along the bottom of the surface water body in the upstream direction. Excess water may be removed from the scoop or spoon. However, this may result in the loss of some fine particle size material associated with the bottom of the surface water body. Care should be taken to minimize the loss of the fine particle sizes. Aliquots of the sample are then placed in a glass pan and homogenized according to the quartering method described in Section 5.13.8 of this SOP.

In surface water bodies that are too deep to wade, but less than eight feet deep, a stainless steel scoop or spoon attached to a piece of conduit can be used either from the banks if the surface water body is narrow or from a boat. Again, care should be taken to minimize the loss of the fine particle sizes. The sediment is placed into a glass pan and mixed according to Section 5.13.8 of this SOP.

If the surface water body has a significant flow and is too deep to wade, a BMH-60 sampler (scoop) may be used. The BMH-60 is not particularly efficient in mud or other soft substrates because its weight will cause penetration to deeper sediments, thus missing the most recently deposited material at the sediment water interface. It is also difficult to release secured samples in an undisturbed fashion that would readily permit subsampling. The BMH-60 may be used provided that caution is exercised by only taking subsamples that have not been in contact with the metal walls of the sampler.

11.2.2 Dredges

For routine analyses, the Peterson dredge can be used when the bottom is rocky, in very deep water, or when the stream velocity is high. The dredge should be lowered very slowly as it approaches bottom, since it can displace and miss fine particle size sediment if allowed to drop freely.

The Eckman dredge has only limited usefulness. It performs well where the bottom material is unusually soft, as when covered with organic sludge or light mud. It is unsuitable, however, for sandy, rocky, and hard bottoms and is too light for use in streams with high velocities. It should not be used from a bridge that is more than a few feet above the water, because the spring mechanism which activates the sampler can be damaged by the messenger if dropped from too great a height.

The Ponar dredge is a modification of the Peterson dredge and is similar in size and weight. It has been modified by the addition of side plates and a screen on the top of the sample compartment. The screen over the sample compartment permits water to pass through the sampler as it descends thus reducing turbulence around the dredge. The Ponar dredge is easily operated by one person in the same fashion as the Peterson dredge. The Ponar dredge is one of the most effective samplers for general use on all types of substrates.

The "mini" Ponar dredge is a smaller, much lighter version of the Ponar dredge. It is used to collect smaller sample volumes when working in industrial tanks, lagoons, ponds, and shallow water bodies. It is a good device use when collecting sludge and sediment containing hazardous constituents because the size of the dredge makes it more amenable to field cleaning.

11.2.3 Coring

Core samplers are used to sample vertical columns of sediment. They are particularly useful when a historical picture of sediment deposition is desired since they preserve the sequential layering of the deposit, and when it is desirable to minimize the loss of material at the sediment-water interface. Many types of coring devices have been developed depending on the depth of water from which the sample is to be obtained, the nature of the bottom material, and the length of core to be collected. They vary from hand push tubes to electronic vibrational core tube drivers.

Coring devices are particularly useful in pollutant monitoring because turbulence created by descent through the water is minimal, thus the fines of the sediment-water interface are only minimally disturbed; the sample is withdrawn intact permitting the removal of only those layers of interest; core liners manufactured of glass or Teflon® can be purchased, thus reducing possible sample contamination; and the samples are easily delivered to the lab for analysis in the tube in which they were collected.

The disadvantage of coring devices is that a relatively small surface area and sample size is obtained often necessitating repetitive sampling in order to obtain the required amount of material for analysis. Because it is believed that this disadvantage is offset by the advantages, coring devices are recommended in sampling sediments for trace organic compounds or metals analyses.

In shallow, wadeable waters, the direct use of a core liner or tube manufactured of Teflon®, plastic, or glass is recommended for the collection of sediment samples. (Plastic tubes are principally used for collection of samples for physical parameters such as particle size analysis). Their use can also be extended to deep waters when SCUBA diving equipment is utilized. Teflon® or plastic are preferred to glass since they are unbreakable which reduces the possibility of sample loss. Stainless steel push tubes are also acceptable and provide a better cutting edge and higher strength than Teflon®. The use of glass or Teflon® tubes eliminates any possible metals contamination from core barrels, cutting heads, and retainers. The tube should be approximately 12 inches in length if only recently deposited sediments (8 inches or less) are to be sampled. Longer tubes should be used when the depth of the substrate exceeds 8 inches. Soft or semi--consolidated sediments such as mud and clays have a greater adherence to the inside of the tube and thus can be sampled with larger diameter tubes. Because coarse or unconsolidated sediments such as sands and gravel tend to fall out of the tube, a small diameter is required for them. A tube about two inches in diameter is usually the best size. The wall thickness of the tube should be about 1/3 inch for Teflon®, plastic, or glass. The inside wall may be filed down at the bottom of the tube to provide a cutting edge and facilitate entry of the liner into the substrate.

Caution should be exercised not to disturb the bottom sediments when the sample is obtained by wading in shallow water. The core tube is pushed into the substrate until four inches or less of the tube is above the sediment-water interface. When sampling hard or coarse substrates, a gentle rotation of the tube while it is being pushed will facilitate greater penetration and decrease core compaction. The top of the tube is then capped to provide a suction and reduce the chance of losing the sample. A Teflon® plug or a sheet of Teflon® held in place by a rubber stopper or cork may be used. After capping, the tube is slowly extracted with the suction and adherence of the sediment keeping the sample in the tube. Before pulling the bottom part of the core above the water surface, it too should be capped.

In deeper, non-wadeable water bodies, sediment cores may be collected from a bridge or a boat using different coring devices such as Ogeechee Sand Pounders®, gravity cores and vibrating coring devices. All three devices utilize a core barrel with a core liner tube system. The core liners can be removed from the core barrel and replaced with a clean core liners, as needed, after each sample. Liners are made of either stainless steel, Teflon or plastic. The type of core liner, and its composition, to collect sediment cores should be based on the contaminants to be evaluated.

Ogeechee Sand Pounders® and gravity Cores are hand held devices that use a standard size 2" core barrel. The core tube and liner are interchangeable between the two units. The Ogeechee® uses a slide hammer mechanism attached to the core head that allows the sampler to pound the core tube into the sediment. The Ogeechee® is good for sandy more consolidated sediments. The gravity core uses a guiding fin mechanism with a built in gravity type check valve. The gravity core is placed in the water and released at the surface to free fall to the bottom. The fin mechanism keeps the core tube upright and free from spinning in the water column as it descends. The core tube stabs the bottom forcing the sediment into the tube. Both coring devices are equipped with removable nose pieces on the core barrel and disposable core catchers for the liner tubes. The core catchers are designed to cap the liner tube to avoid loss of the core when retrieved from the bottom. The gravity core can be modified to attach a slide hammer mechanism, similar to the Ogeechee®, to further pound the core into the sediment further if deemed necessary.

Sediment cores collected from most hand operated coring devices can suffer from either spreading or compaction when driven into the sediment, depending on the softness of the sediment. Spreading occurs s when the sediment is pushed or moved to the side during the advancement of the core tube. Compaction is when the sediment is being pushed downward as the core tune is advanced. Both phenomenon can effect the physical integrity of core sample. For instance, the core tube may be advanced through the sediment to a depth of 36 inches, but upon examination of the recovered core there is only 24 inches of sediment in the core tube.

Vibratory Core Tube Drivers (Vibracore®) facilitates sampling of soft or loosely sedimented saturated soil deposits with minimal compaction or spreading using lined or unlined core tubes. It is designed for use with core tubes having nominal diameters ranging from 2" to 4" OD. The Vibracore® uses an electric motor to create vibration ranges from approximately 6,000 RPM to 8,000 RPM (100 Hz to 133 Hz) depending on the resistance afforded by the soil; the greater the resistance, the higher the frequency. The actual vibrational displacement of the Vibracore® is on the order of a few tens of thousandths of an inch, so essentially no mixing of the sediment within the tube occurs. The vibrational energy tends to re-orient the soil particles at the lower end of the core tube, causing them to move out of the way of the advancing wall of the core tube and into a more efficient (i.e. denser) packing. This action advances the core tube with minimal compaction of the sediment.

When extensive core sampling is required, such as a cross-sectional examination of a streambed (with an objective of profiling both the physical and chemical contents of the sediment), a whole core must be collected. A strong coring tube such as one made from aluminum, steel or stainless steel is needed to penetrate the sediment and underlying clay or sands. A coring device can be used to collect an intact sediment core from water bodies that have soft bottoms which allows several inches of penetration. It is recommended that the corer have a check valve built into the driving head which allows water and air to escape from the cutting core, thus creating a partial vacuum which helps to hold the sediment core in the tube. The corer is attached to a standard auger extension and handle, allowing it to be corkscrewed into the sediment from a boat or while wading. The coring tube is easily detached and the intact sediment core is removed with an extraction device.

Before extracting the sediment from the coring tubes, the clear supernatant above the sediment-water interface in the core should be decanted from the tube. This is accomplished by simply turning the core tube to its side, and gently pouring the liquid out until fine sediment particles appear in the waste liquid. The loss of some of the fine sediments usually occurs with this technique.

11.3 Special Considerations for Collection of Samples for Volatile Organic Compounds

Samples collected for volatile organic compound analyses must be collected prior to any sample homogenization, as described in Section 5.13.8. Regardless of the method used for collection, the aliquot for volatile organic compound analyses must be collected directly from the sampling device, to the extent practical, using equipment and methods described in Section 12.4. The aliquot should be collected directly from the device, such as a hand auger bucket or scoop, if possible. If a device such as a dredge is used, the aliquot should be collected after the sample is placed in the mixing container prior to mixing.

In some cases, the sediment may be soft and not lend itself to collection by plunging Encore or syringe samplers into the sample matrix. In these cases, it is appropriate to open the sample device, i.e., the Encore barrel or syringe, prior to sample collection, and to carefully place the sediment in the device, filling it fully with the required volume of sample.

SECTION 12
SOIL SAMPLING

PERFORMANCE OBJECTIVES:

To collect a soil sample that is representative of conditions as they exist at the site:

- By selecting the appropriate sampling device(s);
- By taking measures to avoid introducing contamination as a result of poor sampling and/or handling technique;
- By reducing the potential of cross contamination between samples.

12.1 Introduction

Prior to conducting a soil sampling investigation, a sampling strategy should be developed based on the objectives of the investigation (Section 5.5 of this SOP contains a discussion of soil sampling strategies). After developing a soil sampling strategy, the appropriate equipment and techniques must be used to conduct the investigation. This section discusses the various soil sample collection methods, sample handling, and available sampling equipment which has been shown to be technically appropriate.

12.2 Equipment

Selection of equipment is usually based on the depth of the samples to be collected, but it is also controlled to a certain extent by the characteristics of the soil. Manual techniques and equipment such as hand augers are usually used for collecting surface or shallow, subsurface soil samples. Power operated equipment is usually associated with deep sampling but can also be used for shallow sampling when the bore hole begins to collapse or when the soil is so tight that manual sampling is not practical.

12.2.1 Precautions for Trace Contaminant Soil Sampling

All soil sampling equipment used for sampling trace contaminants should be constructed of inert materials such as stainless steel where possible. Pans used for mixing should be made of Pyrex® (or equivalent) glass. In no case will chromium, cadmium, galvanized, or plated equipment be used for soil sampling when trace levels of inorganic contaminants are of concern. Similarly, no painted or plastic equipment may be used where trace levels of organic contaminants are of concern. Paint, scaly or heavy rust and grease must be removed before use, most often by sandblasting the equipment. Ancillary equipment such as auger flights may be constructed of other materials since this equipment does not come in direct contact with the samples. The procedures outlined in Section 5.13.7 should be followed.

The procedures outlined in Section 5.13.7 should be followed.

12.3 Sampling Methodology

This discussion of soil sampling methods reflects both the equipment used to collect the sample as well as how the sample is handled and processed after retrieval. Selection of equipment is usually based on the depth of sampling, but it is also controlled, to a certain extent, by the characteristics of the material. Simple, manual techniques and equipment, such as hand augers, are usually selected for surface or shallow, subsurface soil sampling. As the depth of the sampling interval increases, some type of powered sampling equipment is usually needed to overcome the friction induced by soil resistance and depth. The following is an overview of the various sample collection methods employed over three general depth classifications: surface, shallow subsurface, and deep subsurface. Any of the deep collection methods described may be used to collect samples from the shallower intervals.

12.3.1 Manual Collection Techniques and Equipment

These methods are used primarily to collect surface and shallow subsurface soil samples. Surface soils are generally classified as soils between the ground surface and 6 to 12 inches below ground surface. The shallow subsurface interval may be considered to extend from approximately 12 inches below ground surface to a site-specific depth at which sample collection using manual methods becomes impractical.

Surface Soils

Surface soils may be collected with a wide variety of equipment, if constructed of appropriate materials. Spoons or hand-augers are typically used to collect surface soil samples.

If a thick, matted root zone is encountered at or near the surface, it should be removed before the sample is collected. The collected soil is placed in a pan, thoroughly mixed, (Section 5.13.8), and placed in the appropriate sample container(s). Section 12.4 contains specific procedures for collecting and handling soil samples for volatile organic compounds analysis.

Shallow Subsurface Soils

Hand augers are the most common equipment used to collect shallow subsurface samples. Typically, 4-inch auger-buckets with cutting heads are pushed and twisted into the ground, then removed as the buckets are filled. The auger holes are advanced one bucket at a time. The practical depth of investigation using a hand-auger depends upon the soil properties. In sand, augering is usually easily performed, but the depth of collection is limited to the depth at which the sand begins to flow. At this depth, the bore hole will usually collapse and cannot be advanced. Deeper sampling must be accomplished using power equipment. Hand-augering may also be of limited use in tight clays or cemented sands. Regardless of the soil type, at depths approaching 20 feet sidewall friction may become so severe that power equipment must be used.

Power augers such as the Little Beaver® may be used to advance the borehole where hand augers are impractical. Power augers are a sampling aid, not a sampling device, and can be used to advance a borehole to approximately 20 feet, depending upon soil conditions.

If power augers are used to advance the borehole, care must be taken that exhaust fumes, gasoline, and\or oil do not contaminate the borehole. The soil sample may then be collected using a hand auger. After the sample has been collected, the borehole may again be advanced (if necessary), and additional samples collected. The auger bucket must be replaced between samples with a properly decontaminated auger bucket. When a new borehole is advanced, the entire hand auger assembly must be replaced with a properly decontaminated hand auger assembly.

If the borehole is advanced using a hand auger, upon reaching the desired sampling depth replace the bucket with a properly decontaminated bucket. The sample may then be collected. After the sample has been collected, the borehole may be advanced (if necessary) with the bucket that was used to collect the sample. Each sample must be collected using a properly decontaminated bucket.

Before the soil is placed in a pan, it is necessary to remove the top several inches of soil to minimize the possibility of cross-contamination of the sample from fall-in of material from the upper portions of the hole. Once the soil is placed in a pan, it is thoroughly mixed, (Section 5.13.8), and placed in the appropriate sample container(s). Section 12.4 contains specific procedures for collecting and handling soil samples for volatile organic compounds analysis.

12.3.2 Powered Equipment

Powered equipment may be used to acquire soil samples from any depth (surface, shallow subsurface, and deep subsurface). When power equipment is used to advance the borehole and collect the sample, care must be taken that exhaust fumes, gasoline, and\or oil do not contaminate the borehole and the sample. Among the common types of powered equipment used to collect subsurface soil samples are split-spoon samplers driven with a drill rig drive-weight assembly or pushed using drill rig hydraulics; continuous split-spoon samplers; direct-push rigs; and back-hoes. The use of each of these is described below.

<u>Drill Rigs</u>

Drill rigs offer the capability of collecting soil samples from greater depths. For all practical purposes, the depth of investigation achievable by this method is controlled only by the depth of soil overlying bedrock, which may be in excess of 100 feet.

Split-spoon samplers are usually driven either inside a hollow-stem auger or an open borehole after the auger(s) have been temporarily removed. The spoon is driven with a 140-pound hammer through a distance of up to 24 inches and removed.

Continuous split-spoon samplers may be used to obtain five-foot long, continuous samples approximately 3 to 5 inches in diameter. These devices are placed inside a five-foot section of hollow-stem auger and advanced with the auger during drilling. As the auger advances, the central core of soil moves into the sampler and is retained.

Before the soil is placed in a pan, it is necessary to remove the top several inches of soil to minimize the possibility of cross-contamination of the sample from fall-in of material from the upper portions of the hole. Once the soil is placed in a pan, it is thoroughly mixed, (Section 5.13.8), and placed in the appropriate sample container(s). Section 12.4 contains specific procedures for collecting and handling soil samples for volatile organic compounds analysis.

<u>Direct Push Rigs</u>

This method uses a standard split-spoon modified with a locking tip which keeps the spoon closed during the sampling push. Upon arrival at the desired depth, the tip is remotely released and the push continued. During the push, the released tip moves freely inside of the spoon as the soil core displaces it. This technique is particularly beneficial at highly contaminated sites, because no cuttings are produced. The push rods are generally retrieved with very little residue resulting in minimal exposure to sampling personnel and reduced IDW.

Before the soil is placed in a pan, it is necessary to remove the top several inches of soil to minimize the possibility of cross-contamination of the sample from fall-in of material from the upper portions of the hole. Once the soil is placed in a pan, it is thoroughly mixed, (Section 5.13.8), and placed in the appropriate sample container(s). Section 12.4 contains specific procedures for collecting and handling soil samples for volatile organic compounds analysis.

Geoprobe® Large Bore Soil Sampler

Geoprobe® offers several tools for soil sample collection. Among these are the Macro-Core® Soil Sampler and the large bore and dual tube soil sampling systems. The Environmental Investigations Branch utilizes the large bore soil sampling system for collection of surface and subsurface soil samples. The selection of this system does not preclude the use of the other systems at a future time.

The Large Bore sampler is a solid barrel, piston sealed, direct push device for collecting discrete interval samples of unconsolidated materials at depth. The sampler is approximately 30-inches (762 mm) long and has a 1.5-inch (38 mm) outside diameter. The Large Bore sampler is capable of recovering a discrete sample core 22 inches x 1.0 inches (559 mm x 25 mm) contained inside a removable liner. Sample volume measures up to 283 ml. The liner is a 24-inch long by 1.15-inch OD (610 mm x 29 mm) removable/replaceable thin-walled tube that fits inside the Large Bore sample tube. Liners facilitate retrieval of the sample and may be used for storage, when applicable. The Large Bore soil sampler is pushed with 1.25-inch diameter probe rod.

The following is a step-by-step description of the components and procedures used to collect a soil sample with the Large Bore sampler.

Assembly of Large Bore Sampler

1. Select a liner tube and push on to cutting shoe (one end of liner should be slightly flared, push this end on to shoe).

2. Insert end of tube opposite cutting shoe into sample tube and screw cutting shoe firmly into sample tube.

3. Thread piston tip onto piston rod then run piston assembly through the end of the sample tube opposite the cutting shoe, seating the piston tip in the cutting shoe. There should be a short section of exposed piston rod sticking out of sample tube.

4. Place drive head over exposed end of piston rod and thread into end of sample tube.

5. Install piston stop-pin in top of drive head. This retains the piston rod assembly during the push.

6. The Large Bore sampler is now fully assembled and ready for sample collection.

Sample Collection Using Large Bore Sampler

1. Attach assembled Large Bore sampler to end of probe rod.

2. Attach drive cap to probe rod and push rod into ground.

3. Add additional rods to push Large Bore sampler to target sampling depth.

4. At the desired target sampling depth, remove the drive cap to access inside of probe rod.

5. Couple extension rods and extension rod handle together and insert into probe rod. Using handle, turn the extension rods inside probe rod. This should engage the piston-stop pin and remove it from the drive head attached to the top of the sample tube. Retrieve extension rods and attached piston-stop pin.

6. Add addition probe rod, if required, reattach drive cap to top of probe rod and push probe rod and Large Bore sampler 24 inches to fill sampler.

7. Attach pull cap and retrieve tool string.

8. When retrieved, remove the piston rod, with piston tip, and the drive head.

9. Using the Large Bore wrench, unscrew the cutting shoe from the down-hole end of the sample tube.

10. Remove the cutting shoe and attached liner and sample from sample tube.

11. Sample has now been collected and is contained in the liner. At this time, it can be sub-sampled, per analytical requirements.

Special Considerations for Large Bore Soil Sampling

Liner Use and Material Selection

Due to the mode of operation, the Large Bore soil sampler must be used with a liner. Liners are available in the following materials: stainless steel, brass, cellulose acetate butyrate (CAB) and Teflon®. For the majority of environmental investigations conducted by EIB, either CAB or Teflon® liners are used. If samples are collected for organic compound analyses, Teflon® liners are required. CAB liners may be used if metals or other inorganic constituents are the object of the investigation.

Sample Orientation

When the liners and associated sample are removed from the sample tubes, it is important to maintain the proper orientation of the sample. This is particularly important when multiple sample depths are collected from the same push. It is also important to maintain proper orientation to define precisely what depth an aliquot was collected from. Maintaining proper orientation is typically accomplished using vinyl end caps. Convention is to place red caps on the top of liner and black caps on the bottom to maintain the proper sample orientation. Orientation can also be indicated by marking on the exterior of the liner with a permanent marker.

Back-Hoes

Back-hoes may be utilized in the collection of shallow subsurface soil samples. Samples may be collected directly from the bucket, or the trench wall (subject to applicable safety procedures).

The bucket must be free of rust, grease, and paint. Only soil which has not been in contact with the bucket may be sampled, unless the bucket is cleaned according to the procedures described in Appendix B of this SOP.

Trenches offer the capability of collecting samples from very specific intervals and allow visual correlation with vertically and horizontally adjacent material. The sample should be collected without entering the trench itself, if possible. To collect the sample without entering the trench, use a stainless steel scoop attached to rigid electrical conduit with a scoop bracket to "dress" (remove surface layer of soil smeared on the trench wall as the bucket passed) the wall of the trench. Replace the scoop with a decontaminated scoop. Collect the soil.

The collected soil is placed in a pan, thoroughly mixed, (Section 5.13.8), and placed in the appropriate sample container(s). Section 12.4 contains specific procedures for collecting and handling soil samples for volatile organic compounds analysis

12.4 Soil/Sediment Sampling (Method 5035)

The following sampling protocol is recommended for site investigators assessing the extent of volatile organic compounds (VOCs) in soils and sediments at a project site. Because of the large number of options available, careful coordination between field and laboratory personnel is needed. The specific sampling containers and sampling tools required will depend upon the detection levels and intended data use. Once this information has been established, selection of the appropriate sampling procedure and preservation method best applicable to the investigation can be made.

12.4.1 Equipment

Soil\sediment for VOC analyses may be retrieved using the equipment specified in Sections 11 and 12 of this SOP. Once the soil\sediment has been obtained, the EnCore™ VOC sampler, syringes, stainless steel spatula, standard 2 oz soil VOC container, or pre-prepared 40 mL vials may be used/required for sub-sampling collection. The specific sample containers and the sampling tools required will depend upon the data quality objectives established for the site or sampling investigation. The various methods are described below.

12.4.2 Sampling Methodology - Low Concentrations

When total VOC concentrations in the soil/sediment are expected to be less than 200 μg/kg, the samples may be collected directly with the EnCore™ sampler or syringe. If using the syringes, the sample must be placed in the sample container (40 ml pre-prepared vial) immediately to reduce volatilization losses. The 40 ml vials should contain 10 ml of organic free water for an un-preserved sample or approximately 10 ml of organic free water and a preservative. It is recommended that the 40 ml vials be prepared and weighed by the laboratory (commercial sources are available which supply preserved and tared vials). When sampling directly with the EnCore™ sampler, the vial must be immediately capped.

A soil/sediment sample for VOC analysis may also be collected with conventional sampling equipment (as described in Sections 11 and 12 of this SOP). A sample collected in this fashion must either be placed in the final sample container (EnCore™ or 40 ml pre-prepared vial) immediately or the sample may be immediately placed into an intermediate sample container with no head space. If an intermediate container (usually 2 oz. soil jar) is used, the sample must be transferred to the final sample container (EnCore™ or 40 ml pre-prepared vial) as soon as possible not to exceed 30 minutes.

NOTE: After collection of the sample into either the EnCore™ Sampler or other container, the sample must immediately be stored in an ice chest and cooled.

Soil\sediment samples may be prepared for shipping and analysis as follows:

EnCore™ Sampler - the sample may simply be capped, locked and secured in a plastic bag.

Syringe - Add about 3.7 cc (approximately 5 grams) of sample material to 40 ml pre-prepared containers. Secure the containers in a plastic bag. Do not use a custody seals on the container, place the custody seal on the plastic bag. Note: When using the syringes, it is important that no air is allowed to become trapped behind the sample prior to extrusion, as this will adversely affect the sample.

Stainless Steel Laboratory Spatulas - Add between 4.5 and 5.5 grams (approximate) of sample material to 40 ml containers. Secure the containers in a plastic bag. Do not use a custody seal on the container, place the custody seal on the plastic bag.

12.4.3 Sampling Methodology - High Concentrations

Based upon the data quality objectives and the detection level requirements, this high level method may also be used. Specifically, the sample may be packed into a single 2-oz. glass container with a screw cap and septum seal. The sample container must be filled quickly and completely to eliminate head space. Soils\sediments containing high total VOC concentrations may also be collected as described in Section 12.4.2, and preserved using 10 ml methanol.

12.4.4 Waste Samples

Collect an un-preserved sample into a single 2 – oz glass container. Handle waste samples in accordance with Section 14 of this SOP.

12.4.5 Special Techniques and Considerations

<u>Effervescence</u>

If low concentration samples effervesce from contact with the acid preservative, (see Sec. 12.4.2) then either a test for effervescence must be performed prior to sampling, or the investigators must be prepared to collect each sample both preserved or un-preserved as needed, or all samples must be collected un-preserved.

To check for effervescence, collect a test sample and add to a pre-preserved vial. If preservation (acidification) of the sample results in effervescence (rapid formation of bubbles) then preservation by acidification is not acceptable, and the sample must be collected un-preserved.

If effervescence occurs and only pre-preserved sample vials are available, the preservative solution may placed into an appropriate hazardous waste container and the vials triple rinsed with organic free water. An appropriate amount of organic free water, equal to the amount of preservative solution, should be placed into the vial. The sample may then be collected as an un-preserved sample. Note that the amount of organic free water placed into the vials will have to be accurately measured.

Sample Size

While this method is an improvement over earlier ones, field investigators must be aware of an inherent limitation. Because of the extremely small sample size, sample representativeness for VOC's may be reduced compared to samples with larger volumes collected for other constituents . The sampling design and objectives of the investigation should take this into consideration.

Holding Times

Sample holding times are specified in Appendix A. Field investigators should note that the holding time for an un-preserved VOC soil/sediment sample is 48 hours. Arrangements should be made to ship the soil/sediment VOC samples to the laboratory by overnight delivery the day they are collected so the laboratory may preserve and\or analyze the sample within 48 hours of collection.

Percent Moisture

Samplers must ensure that the laboratory has sufficient material to determine percent moisture in the VOC soil/sediment sample to correct the analytical results to dry weight. If other analyses requiring percent moisture determination are being performed upon the sample, these results may be used. If not, a separate sample (minimum of 2 oz.) for percent moisture determination will be required.

Safety

Methanol is a toxic and flammable liquid. Therefore, methanol must be handled with all required safety precautions related to toxic and flammable liquids. Inhalation of methanol vapors must be avoided. Vials should be opened and closed quickly during the sample preservation procedure. Methanol must be handled in a ventilated area. Use protective gloves when handling the methanol vials. Store methanol away from sources of ignition such as extreme heat or open flames. The vials of methanol should be stored in a cooler with ice at all times.

Shipping

Methanol and sodium bisulfate are considered dangerous goods, therefore shipment of samples preserved with these materials by common carrier is regulated by the U.S. Department of Transportation and the International Air Transport Association (IATA). The rules of shipment found in Title 49 of the Code of Federal Regulations (49 CFR parts 171 to 179) and the current edition of the IATA Dangerous Goods Regulations must be followed when shipping methanol and sodium bisulfate. Consult the above documents or the carrier for additional information. Shipment of the quantities of methanol and sodium bisulfate used for sample preservation falls under the exemption for small quantities. A summary of the requirements for shipping samples follows. Refer to the code for a complete review of the requirements.

1. The maximum volume of methanol or sodium bisulfate in a sample container is limited to thirty30) mls.

2. The sample container must not be full of methanol.

3. The sample container must be stored upright and have the lid held securely in place. Note that the mechanism used to hold the cap in place must be able to be completely removed so weight is not added to the sample container, as specified in Method 5035.

4. Sample containers must be packed in a sorbent material capable of absorbing spills from leaks or breakage of the sample containers.

5. The maximum sample shuttle weight must not exceed 64 pounds.

6. The maximum volume of methanol or sodium bisulfate per shipping container is 500 mls.

7. The shipper must mark the sample shuttle in accordance with shipping dangerous goods in acceptable quantities.

8. The package must not be opened or altered until no longer in commerce.

12.4.6 Summary

The following summary table lists the options available for compliance with SW846 Method 5035. The advantages and disadvantages are noted for each option. SESD's goal is to minimize the use of hazardous material (methanol and sodium bisulfate) and minimize the generation of hazardous waste during sample collection.

OPTION	PROCEDURE	ADVANTAGES	DISADVANTAGES
1	Collect 2 - 40 mL vials with ~5 grams of sample and 1 - 2 oz., glass w/septum lid for screening and % moisture	Screening conducted by lab	Presently a 48 hour holding time for unpreserved samples
2	Collect 3 Encore™; and 1- 2 oz., glass w/septum lid for screening and % moisture	Lab conducts all preservation/preparation procedures	Presently a 48 hour holding time for preparation of samples
3	Collect 2 - 40 ml vials with 5 grams of sample and preserve w/methanol or sodium bisulfate and 1 - 2-oz., glass w/septum lid for screening and % moisture	High level VOC samples may be composited Longer holding time	Hazardous materials used in field
4	Collect 1 - 2-oz., glass w/septum lid for analysis and % moisture	Lab conducts all preservation/preparation procedures	May have significant VOC loss

SECTION 13
WASTE SAMPLING

SECTION OBJECTIVE:

- To describe equipment and procedures that can safely be used to collect waste samples.

13.1 Introduction

Hazardous wastes are regulated by the US EPA under 40 CFR Parts 260-265. As a consequence, many of the methods that are used to manage, store, treat, and dispose hazardous wastes and potential hazardous wastes are of concern to both the regulators and the regulated community.

Samples are often required of regulated or potentially regulated materials. While it is understood that each facility and wastestream may present its own unique sampling and analytical challenges, this section will list equipment and procedures that have been used to safely and successfully sample specific waste units.

13.1.1 Safety

Sampling of waste units should, be assessed for potential hazards by both the project leader and the site safety officer (SSO). It is the SSOs responsibility to enforce the site safety plan, and to ensure that procedures used during waste sampling are in accordance with Branch safety procedures and protocols found in Section 4.

Sampling equipment contaminated during waste sampling investigations should be cleaned with laboratory detergent and rinsed with tap water prior to returning the equipment from the field. Contaminated sampling equipment that is to be discarded must be properly disposed according to Section 5.15 and should be specified in the site-specific study plan.

13.1.2 Quality Control Procedures

In some instances, special decontamination procedures will be necessary and should be developed on a case-by-case basis according to the specific material encountered. Any cleaning procedures and equipment repairs conducted in the field which deviate from those specified in Appendix B or the study plan, should be thoroughly documented in the logbooks.

All air monitoring and field analytical/screening equipment should be checked and calibrated before being issued for field studies, as specified in Sections 16 and 17 of this SOP.

13.1.3 Collection of Auxiliary Information and Data

The collection of auxiliary information and data is particularly important when collecting waste samples. Any field analyses or field screening results should be recorded in a logbook as outlined in Section 3.5. Sketches of waste units, sampling locations, containers, tanks and ancillary equipment, markings/labels, etc., should be fully documented in logbooks. Photographs are extremely useful for recording this information and may be used during waste sampling operations. A field log of the photographs taken should be maintained as outlined in Section 3.2.2.

13.2 Waste Unit Types

Waste management units can be generally categorized into two types: open and closed. In practice, open units are larger than closed units. Open units include waste piles and surface impoundments whereas closed units include containers and tanks as well as ancillary tank equipment. Besides containers and tanks, sumps may also be considered closed units because they are designed to collect the spillage of liquid wastes and are sometimes configured as a confined space.

Although both may pose hazards, units that are open to the environment are generally less hazardous than closed units. Sampling of closed units is considered a higher hazard risk because of the potential of exposure to toxic gases and flammable/explosive atmospheres. Because closed units prevent the dilution of the wastes by environmental influences, they are more likely to contain materials that have concentrated levels of hazardous constituents. While opening closed units for sampling purposes, investigators shall use Level B personnel protective equipment, (PPE) air monitoring instruments to ensure that the working environment does not contain hazardous levels of flammable/explosive gasses or toxic vapors, and follow the appropriate safety requirements stipulated in the site specific safety plan.

Buried waste materials should be located and excavated with extreme caution. Once the buried waste is uncovered, the appropriate safety and sampling procedures utilized will depend on the type of waste unit.

13.2.1 Open Units

While open units may contain many types of wastes and come in a variety of shapes and sizes, they can be generally regarded as either waste piles or surface impoundments. Definitions of these two types of open units from 40 CFR Part 260.10 are:

- Waste pile -- any non-containerized accumulation of solid, non-flowing hazardous waste that is used for treatment or storage and that is not a containment building.

- Surface impoundment -- "...a facility or part of a facility which is a natural topographic depression, man-made excavation, or diked area formed primarily of earthen materials (although it may be lined with man-made materials), which is designed to hold the accumulation of liquid wastes or wastes containing free liquids, and which is not an injection well. Examples of surface impoundments are holding, storage, settling and aeration pits, ponds, and lagoons."

One of the distinguishing features between waste piles and surface impoundments is the state of the waste. Waste piles typically contain solid or non-flowing materials whereas liquid wastes are usually contained in surface impoundments. The nature of the waste will also determine the mode of delivering the waste to the unit. Wastes are commonly pumped or gravity fed into impoundments while heavy equipment or trucks may be used to dump wastes in piles. Once the waste has been placed in an open unit, the state of the waste may be altered by environmental factors (e.g., temperature, precipitation, etc.).

Surface impoundments may contain several phases such as floating solids, liquid phase(s), and sludges. Waste piles are usually restricted to solids and semi-solids. All of the potential phases contained in a waste unit should be considered in developing the sample design to meet the study's objective.

13.2.2 Closed Units

There are a variety of designs, shapes, sizes, and functions of closed units. In addition to the challenges of the various designs and the safety requirements for sampling them, closed units are difficult to sample because they may contain liquid, solid, semi-solid/sludge, or any combination of phases. Based on the study's design, it may be necessary to obtain a cross sectional profile of the closed unit in an attempt to characterize the unit. The following are definitions of types of closed waste units described in 40 CFR Part 260.10:

- Container -- any portable device in which a material is stored, transported, treated, disposed, or otherwise handled. Examples of containers are drums, overpacks, pails, totes, and roll-offs.

- Tank -- a stationary device, designed to contain an accumulation of hazardous waste which is constructed primarily of non-earthen materials which provide structural support.

Portable tanks, tank trucks, and tank cars vary in size and may range from simple to extremely complex designs. Depending on the unit's design, it may be convenient to consider some of these storage units as tanks for sampling purposes even though they meet the definition of a container.

- Ancillary equipment (tank) -- any device including, but not limited to, such devices as piping, fittings, flanges, valves, and pumps that is used to distribute, meter, or control the flow of hazardous waste from its point of generation to a storage or treatment tank(s), between hazardous waste storage and treatment tanks to a point of disposal on-site, or to a point of shipment for disposal off-site.

- Sump -- any pit or reservoir that meets the definition of a tank and those troughs/trenches connected to it that serve to collect hazardous wastes.

Note: some outdoor sumps may be considered open units/surface impoundments.

Although any of the closed units may not be completely sealed and may be partially open to the environment, the unit needs to be treated as a closed unit for sampling purposes until a determination can be made. Once a closed unit is opened, a review of the proposed sampling procedures and level of protection can be performed to determined if the (PPE) is suitable for the site conditions.

Samples collected from different waste units should not be composited into one sample container without additional analytical and/or field screening data to determine if the materials are compatible and will not cause an inadvertent chemical reaction.

13.3 Equipment

Selecting appropriate equipment to sample wastes is a challenging task due to the uncertainty of the physical characteristics and nature of the wastes. It may be difficult to separate, homogenize and/or containerize a waste due to its physical characteristics (viscosity, particle size, etc.). In addition, the physical characteristics of a waste may change with temperature, humidity, or pressure. Waste streams may vary depending on how and when a waste was generated, how and where it was stored/disposed, and the conditions under which it was stored/disposed. Also, the physical location of the wastes or the unit configuration may prevent the use of conventional sampling equipment.

Given the uncertainties that a waste may present, it is desirable to select sampling equipment that will facilitate the collection of samples that will meet the study's objective, and that will not unintentionally bias the sample by excluding some of the sample population that is under consideration. However, due to the nature of some waste matrices or the physical constraints of some waste units, it may be necessary to collect samples knowing that a portion of the desired population was omitted due to limitations of the equipment. Any deviations from the study plan or difficulties encountered in the field concerning sample collection that may have an effect on the study's objective should be documented in a log book, reviewed with the analytical data, and presented in the report.

13.3.1 Waste Sampling Equipment

Waste sampling equipment should be made of non-reactive materials that will neither add to nor alter the chemical or physical properties of the material that is being sampled. Table 13.3.1 lists some conventional equipment for sampling waste units/phases and some potential limitations of the equipment. Another reference for selecting sampling equipment is the ASTM, Standard Guide for Selection of Sampling Equipment for Wastes and Contaminated Media Data Collection Activities, D 6232-98.

13.3.2 Ancillary Equipment for Waste Sampling

In addition to the equipment listed in Table 13.3.1 which provides the primary device used to collect various waste samples, ancillary equipment may be required during the sampling for safety and/or analytical reasons. Some examples of these types of equipment are glass mixing pans, particle size reducers, remote drum opening devices, and spark resistant tools. See Section 13.7 for particle size reduction procedures. Any influences that these types of ancillary equipment may have on the data should be evaluated and reported as necessary.

TABLE 13.3.1
SAMPLING EQUIPMENT for VARIOUS WASTE UNITS

Equipment	Waste Units/Phases	Limitations
scoop with bracket/conduit	impoundments, piles, containers, tanks/liquids, solids, sludges	Can be difficult to collect deeper phases in multiphase wastes. Depth constraints.
spoon	impoundments, piles, containers/solids, sludges	Similar limitations as the scoop. Generally not effective in sampling liquids.
push tube	piles, containers/cohesive solids, sludges	Should not be used to sample solids with dimensions >½ the diameter of the tube. Depth constraints.
auger	impoundments, piles, containers/solids	Can be difficult to use in an impoundment or a container, or for solidified wastes.
sediment sampler	impoundments, piles/ solids, sludges	Should not be used to sample solids with dimensions >½ the diameter of the tube.
ponar dredge	impoundments/solids, sludges	Must have means to position equipment to desired sampling location. Difficult to decon.
COLIWASA or drum thief	impoundments, containers, tanks/liquids	Not good with viscous wastes. Devices ≥ 7' require 2 samplers to use effectively.
Dipstick™ / Mucksucker™	impoundments, containers, tanks/liquids, sludges	Not recommended for tanks >11 feet deep. Devices ≥ 7' require 2 samplers to use effectively.
bacon bomb	impoundments, tanks/ liquids	Not good with viscous wastes.
bailer	impoundments, tanks/ liquids	Only if waste is homogeneous. Not good with viscous wastes.
peristaltic pump with vacuum jug assembly	impoundments, tanks/ liquids	Cannot be used in flammable atmospheres. Not good with viscous wastes.
back-hoe bucket	piles/solids, sludges	May be difficult to access desired sampling location. Difficult to decon. Can lose volatiles.
split-spoon	piles/solids	Requires drill rig or direct push equipment.
roto-hammer	piles, containers/solids	Physically breaks up sample. May release volatiles. Not for flammable atmospheres.

13.4 Waste Sampling Procedures

13.4.1 Waste Piles

Waste piles vary in size, shape, composition, and compactness, and may vary in distribution of hazardous constituents and characteristics (strata). These variables will affect safety and access considerations. The number of samples, the type of sample(s), and the sample location(s) should be based on the study's objectives. Commonly used equipment to collect samples from waste piles are listed in Table 13.3.1. All equipment should be compatible with the waste and should have been cleaned to prevent any cross contamination of the sample.

13.4.2 Surface Impoundments

Surface impoundments vary in size, shape, and waste content, and may vary in distribution of hazardous constituents and characteristics (strata). The number of samples, the type of sample(s), and the sample location(s) should be based on the study's objectives. Commonly used equipment to collect samples from surface impoundments are listed in Table 13.3.1. All equipment should be compatible with the waste and should have been cleaned to prevent any cross contamination of the sample.

Because of the potential danger of sampling waste units suspected of containing elevated levels of hazardous constituents, personnel should never attempt to sample surface impoundments used to manage potentially hazardous wastes from a boat. All sampling should be conducted from the banks or piers of surface impoundments. Any exception must be approved by the appropriate site safety officer and/or the Occupational Health and Safety Designee (OHSD).

13.4.3 Drums

Drums are the most frequent type of containers sampled by field investigators for chemical analyses and/or physical testing. Caution should be exercised by the field investigators when sampling drums because of the potential presence of explosive/flammable gases and/or toxic vapors. Therefore, the following procedures should be used when collecting samples from drums of unknown material:

1. Visually inspect all drums that are being considered for sampling for the following:

    - pressurization (bulging/dimples);
    - crystals formed around the drum opening;
    - leaks, holes, stains;
    - labels, markings;
    - composition and type (steel/poly and open/bung);
    - condition, age, rust; and
    - sampling accessibility.

    Drums showing evidence of pressurization and crystals should be furthered assessed to determine if remote drum opening is needed. If drums cannot be accessed for sampling, heavy equipment is usually necessary to stage drums for the sampling activities. Adequate time should be allowed for the drum contents to stabilize after a drum is handled.

2. Identify each drum that will be opened (e.g., paint sticks, spray paint, cones, etc).

LEVEL "B" PROTECTION IS REQUIRED FOR THE FOLLOWING PROCEDURES.

3. Before opening, ground each metal drum that is not in direct contact with the earth using grounding wires, alligator clips, and a grounding rod or metal structure. If a metal drum is in an overpack drum, the metal drum should be grounded.

4. Touch the drum opening equipment to the bung or lid and allow an electrical conductive path to form. Slowly remove the bung or drum ring and/or lid with spark resistant tools (brass/beryllium).

5. Screen drums for explosive gases and toxic vapor with air monitoring instruments as bung or drum lid is removed. Depending on site conditions screen for one or more of the following:

   - radioactivity;
   - cyanide fumes;
   - halogen vapors;
   - pH; and/or
   - flash point (requires small volume of sample for testing).

   Note the state, quantity, phases, and color of the drum contents. Record all relevant results, observations, and information in a logbook, Drum Data Form or Drum Data Table. Figure 13-1 is an example of a Drum Data Form. Review the screening results with any pre-existing data to determine which drums will be sampled.

6. Select the appropriate sampling equipment based on the state of the material and the type of container. Sampling equipment should be made of non-reactive materials that will meet the study's objective(s).

7. Place oil wipe (as necessary), sampling equipment, and sample containers near drum(s) to be sampled.

AIR MONITORING FOR TOXIC VAPORS AND EXPLOSIVE GASES AND OXYGEN DEFICIENT ATMOSPHERES SHOULD BE CONDUCTED DURING DRUM SAMPLING.

   Liquids -- Slowly lower the COLIWASA or drum thief to the bottom of the container. Close the COLIWASA with the inner rod or create a vacuum with the sampler's gloved thumb on the end of the thief and slowly remove the sampling device from the drum. Release the sample from the device into the sample container. Repeat the procedure until a sufficient sample volume is obtained.

   Solids/Semi-Solids -- Use a push tube, bucket auger, or screw auger or if conditions permit a pneumatic hammer/drill to obtain the sample. Carefully use a clean stainless steel spoon to place the sample into container(s) for analyses.

8. Close the drums when sampling is complete. Segregate contaminated sampling equipment and investigative derived wastes (IDW) containing incompatible materials as determined by the drum screening procedure (Step #5). At a minimum, contaminated equipment should be cleaned with laboratory detergent and rinsed with tap water prior to returning it from the field. IDW should be managed according to Section 5.15, and Region 4's Contaminated Media Policy.

FIGURE 13-1
DRUM DATA FORM

Date ___________________ Page ________

SAMPLE COLLECTED: Y / N

PROJECT NO.____________ SITE NAME:____
CITY ___________________ STATE: ____

EPA DRUM ID# ___________ OTHER DRUM ID# ____________________________

DRUM OBSERVATIONS:

1) OVERPACK: Y / N METAL / PLASTIC / OTHER ____________________
SIZE: 85 / 55 / _________

2) DRUM: METAL / PLASTIC / OTHER __________________________________
SIZE: 85 / 55 / _________
CONDITION: GOOD / FAIR / POOR
MARKINGS / LABELS:____

3) DRUM OPENING TEAM: ____
4) ESTIMATED VOLUME: FULL / ¾ / ½ / ¼ / EMPTY

5) PHYSICAL APPEARANCE OF DRUM CONTENTS:

COLOR: ______________________ VISCOSITY: LOW / MED / HIGH
PHASED: Y / N ; DESCRIPTION:____
OTHER: ____

6) AIR MONITORING RESULTS:

PID	________ ppm	EXPLOS	_____ $\%O_2$	%LEL
FID	________ ppm	HALOGEN	Yes	No
CN	________ ppm	pH	____________	
RAD	________ Mrem		____________	

7) FLASH POINT SAMPLE COLLECTED: YES / NO
FLASH RESULTS AT 140°F: YES / NO
HOT WIRE TEST FOR HALOGEN: POS / NEG

8) SAMPLE COLLECTED: YES / NO TIME: ___________
COLLECTOR(S):____

13.4.4 Tanks

Sampling tanks is considered hazardous due to the potential for them to contain large volumes of hazardous materials and therefore, appropriate safety protocols must be followed. Unlike drums, tanks may be compartmentalized or have complex designs. Preliminary information about the tank's contents and configuration should be reviewed prior to the sampling operation to ensure the safety of sampling personnel and that the study's objectives can be achieved.

In addition to having discharge valves near the bottom of tanks and bulk storage units, most tanks have hatches at the top. It is desirable to collect samples from the top hatch because of the potential for the tank's contents to be stratified. Additionally, when sampling from the discharge valve, there is a possibility of a stuck or broken valve which could cause an uncontrolled release. Investigators should <u>not</u> utilize valves on tanks or bulk storage devices unless they are operated by the owner or operator of the facility, or a containment plan is in place should the valve stick or break. If the investigator must sample from a tank discharge valve, the valving arrangement of the particular tank must be clearly understood to insure that the compartment(s) of interest is sampled.

Because of the many different types of designs and materials that may be encountered, only general sampling procedures that outline sampling a tank from the top hatch are listed below:

1. All relevant information concerning the tank such as the type of tank, the tank capacity, markings, condition, and suspected contents should be documented in a logbook.

2. The samplers should inspect the ladder, stairs, and catwalk that will be used to access the top hatch to ensure that they will support the samplers and their equipment.

LEVEL "B" PROTECTION IS REQUIRED FOR THE FOLLOWING PROCEDURES.

3. Before opening, ground each metal tank using grounding wires, alligator clips, and a grounding rod or metal structure.

4. Any vents or pressure release valves should be slowly opened to allow the unit to vent to atmospheric pressure. Air monitoring for explosive/flammable gases and toxic vapors should be conducted during the venting with the results recorded in a log book. If dangerous concentrations of gases evolve from the vent or the pressure is too great, leave the area immediately.

5. Touch tank opening equipment to the bolts in the hatch lid and allow electrical conductive path to form. Slowly remove bolts and/or hatch with spark resistant tools (brass/beryllium). If a pressure build up is encountered or detected, cease opening activities and leave the area.

6. Screen tanks for explosive/flammable gases and toxic vapors with air monitoring instruments. Depending on the study objectives and site conditions, conduct characteristic screening (e.g., pH, halogen, etc.) as desired. Collect a small volume of sample for flash point testing, if warranted. Note the state, quantity, number of phases, and color of the tank contents. Record all relevant results, observations, and information in a logbook. Compare the screening results with any pre-existing data to determine if the tank should be sampled.

7. Select the appropriate sampling equipment based on the state of the material and the type of tank. Sampling equipment should be constructed of non-reactive materials that will meet the study's objective(s).

8. Place oil wipe (as necessary), sampling equipment, and sample containers near tanks(s) to be sampled.

AIR MONITORING FOR TOXIC VAPORS, EXPLOSIVE GASES AND OXYGEN DEFICIENT ATMOSPHERES SHOULD BE CONTINUOUS DURING TANK SAMPLING.

Liquids -- Slowly lower the bailer, bacon bomb, Dipstick™, COLIWASA, or Teflon® tubing to the desired sampling depth. (NOTE: In work areas where explosive/flammable atmospheres could occur, peristaltic pumps powered by 12 V. batteries should not be used.) Close the sampling device or create a vacuum and slowly remove the sampling device from the tank. Release the sample from the device into the sample container. Repeat the procedure until a sufficient sample volume is obtained.

Solids/Semi-Solids - Use a push tube, bucket auger, screw auger, Mucksucker™, or if conditions permit a pneumatic hammer/drill to obtain the sample. Carefully extrude the sample from the sampling device or use a clean stainless steel spoon to place the sample into containers for analyses.

9. Close the tank when sampling is complete. Segregate contaminated sampling equipment and investigative derived wastes (IDW) containing incompatible materials as determined by the screening procedure (Step #6). At a minimum, contaminated equipment should be cleaned with laboratory detergent and rinsed with tap water prior to returning it from the field. IDW should be managed according to Section 5.15, and Region 4's Contaminated Media Policy.

13.5 Miscellaneous Contaminated Materials

Sampling may be required of materials or equipment (e.g., documents, building materials, equipment, etc.) to determine whether or not various surfaces are contaminated by hazardous constituents, or to evaluate the effectiveness of decontamination procedures.

Wipe or swab samples may be taken on non-absorbent, smooth surfaces such as metal, glass, plastic, etc. The wipe materials must be compatible with the solvent used and the analyses to be performed, and should not come apart during use. The wipes are saturated with a solvent; methylene chloride, hexane, isopropanol or analyte free water depending on the parameters to be analyzed. The laboratory performing the analyses can provide the appropriate solvent. Wipe samples should not be collected for volatile organic compounds analysis. Sampling personnel should be aware of hazards associated with the selected solvent and should take appropriate precautions to prevent any skin contact or inhalation of these solvents. All surfaces and areas selected for sampling should be based on the study's objectives. Typically, 10 cm by 10 cm templates are prepared from aluminum foil which are secured to the surface of interest. The prepared (saturated with solvent) wipe(s) is removed from its container with tongs or gloves, and used to wipe the entire area with firm strokes using only one side of the wipe. The goal is to systematically wipe the whole area. The wipe is then folded with the sample side inward and placed into the sample container. This procedure is repeated until the area is free of visible contamination or no more wipes remain. Care should be taken to keep the sample container tightly sealed to prevent evaporation of the solvent. Samplers must also take care to not touch the used side of the wipe. All requests for support from the Region 4 laboratory for wipe preparations and wipe analyses should be made well in advance of the scheduled sampling event. (Note: if gloves are used to collect the wipe samples, control samples should be collected to determine if the gloves could potentially contribute constituents to the parameters of interest.)

For items with porous surfaces such as documents (usually business records), insulation, wood, etc., actual samples of the materials are required. It is therefore important, that during the collection and/or analyses of the sample that evidentiary material is not destroyed. Use scissors or other particle reduction device that have been cleaned as specified in Appendix B to cut/shred the sample. Mix in a glass pan as specified in Section 5.13.8. The shredded, homogenized material is then placed in sample containers.

13.6 Waste Sample Handling Procedures

When collecting samples of concentrated wastes for laboratory analyses, field personnel are required to screen the waste materials to ensure safe handling and transportation of the samples. Safety procedures, sampling and screening methods used to collect the samples must comply with those procedures/methods described in this manual. It should be noted that waste samples should not be preserved because of the potential for an inadvertent chemical reaction with the preservative. Additionally, concentrated waste samples are not required to be cooled to 4°C.

After samples have been collected and containerized, the outside of the sample containers should be cleaned with water, paper towels and/or oil wipes to remove any spilled material from the exterior of the container. It should be noted that each sample container should be tagged and sealed, placed in a plastic bag, and the bag securely closed. Samples collected from materials that did not demonstrate any hazardous characteristics during the screening process may be placed in coolers and handled as non-hazardous samples in accordance with Appendix A.

Field investigators will use knowledge gained of site practices and processes, labels and marking on waste containers, field screening results, and personal observations made during their investigation to determine the hazard potential of a sample. Samples considered to be hazardous by the field investigators will be placed in secondary containment for transport to the SESD laboratory and for subsequent handling upon arrival. The tagged, sealed and bagged samples will be placed in a 6-quart plastic pail, packed with vermiculite, and sealed with a tight fitting lid. The project number for the sampling investigation and the specific sample station number will be marked on the secondary container in indelible ink. A standard SESD Hazard Communication Label will be affixed to the side of the secondary container. The appropriate hazard(s) for the sample (Health, Flammability, and/or Reactivity) will be indicated with an "X". Additionally, an "X" will be placed in the "Protective Equipment" section.

All secondary containing pails will be secured in the vehicles while transporting the samples from the field to the laboratory for analyses. In addition, each pail should indicate when protective equipment is recommended to handle the actual waste/sample material.

13.7 Particle Size Reduction

Particle size reduction of waste samples is periodically required in order to complete an analytical scan or the Toxicity Characteristic Leaching Procedure (TCLP) test. Samples that may require particle size reduction include slags, bricks, glass/mirror cullet, wire, etc. Method 1311 (TCLP) states "Particle size reduction is required, unless the solid has a surface area per gram of material equal to or greater than 3.1 cm^2, or is smaller than 1 cm in its narrowest dimension (i.e., capable of passing through a 9.5 mm (0.375 inch) standard sieve). If the surface area is smaller or the particle size larger than described above, prepare the solid portion of the waste for extraction by crushing, cutting, or grinding the waste to a surface area or particle size as described above" (55 FR 26990). The method also states that the surface criteria are meant for filamentous (paper, cloth, etc.) waste materials, and that "Actual measurement of the surface area is not required, nor is it recommended". Also, the loss of volatile organic compounds could be significant during particle size reduction.

Waste samples that require particle size reduction are often too large for standard sample containers. If this is the case, the sample should be secured in a clean plastic bag and processed using normal chain-of-custody procedures (Section 3). Note that the tags that will be required for the various containers should be prepared in the field and either inserted into or attached to the sample bag. The bag should then be sealed with a custody seal.

Because of the difficulty in conducting particle size reduction, it is typically completed at the Field Equipment Center (FEC). The following procedure may be used for crushing and/or grinding a solid sample:

1. Remove the entire sample, including any fines that are contained in the plastic bag and place them on the standard cleaned stainless steel pan.

2. Using a clean hammer, carefully crush or grind the solid material (safety glasses are required), attempting to minimize the loss of any material from the pan. Some materials may require vigorous striking by the hammer, followed by crushing or grinding. The material may be subject to crushing/grinding rather than striking.

3. Continue crushing/grinding the solid material until the sample size approximates 0.375 inch. Attempt to minimize the creation of fines that are significantly smaller than 0.375 inch in diameter.

4. Pass the material through a clean 0.375-inch sieve into a glass pan.

5. Continue this process until sufficient sample is obtained. Thoroughly mix the sample as described in Section 5.13.8 of this SOP. Transfer the contents of the glass pan into the appropriate containers.

6. Attach the previously prepared tags and submit for analyses.

13.8 REFERENCES

1. Title 40 Code of Federal Regulations, Parts 260-265, US-EPA, July 1, 2000.

2. ASTM, Standard Guide for Selection of Sampling Equipment for Wastes and Contaminated Media Data collection Activities, D 6232-98, 1998.

3. ASTM, Standard Guide for Sampling Stategies for Heterogeneous Wastes, D 5956-96, 1996.

4. Test Methods for Evaluating Solid Waste - Physical/Chemical Methods (SW-846), Third Edition, Draft Update IVB, US-EPA, Office of Solid Waste and Emergency Response, Washington, D.C., November, 2000.

5. Compendium of ERT Waste Sampling Procedures, US-EPA, EPA/540/P-91/008 (OSWER Directive 9360.4-07), January 1991.

6. Characterization of Hazardous Waste Sites - A Methods Manual: Volume I -Site Investigations, US-EPA, EMSL, Las Vegas, EPA-600/4-84-075, April 1985.

7. Characterization of Hazardous Waste Sites - A Methods Manual: Volume II -Available Sampling Methods, 2nd Edition, US-EPA, EMSL, Las Vegas, EPA 600/4-84-076, December 1984.

8. Federal Register,Volume: 55, Issuse 26, Page: 26990, Friday, June 29, 1990.

SECTION 14
AMBIENT AIR MONITORING

PERFORMANCE OBJECTIVE:

- To present the standard operating procedures and sample collection methodologies for conducting air monitoring in ambient air.
- To collect an air sample that is representative of conditions as they existed at the site.
- To Take measures to avoid introducing contamination as a result of poor sampling and/or handling technique.

14.1 Introduction

This section discusses the sample collection and analytical procedures used for air monitoring in Region 4. Air toxics as used in this SOP means air pollutants for which National Ambient Air Quality Standards have not been established. Criteria pollutants mean air pollutants which National Ambient Air Quality Standards have been established.

14.2 Criteria Pollutant Monitoring (Reference/Equivalent Monitors) for Air Pollutants for which National Ambient Air Quality Standards have been Established

14.2.1 Monitoring Ozone in Ambient Air

The following is a synopsis of procedures which should be strictly adhered to for the monitoring of ozone in air. This summary is adapted from 40 CFR Part 50, Appendix D -Measurement Principle and Calibration Procedure for The Measurement of Ozone in The Atmosphere, and The Quality Assurance Handbook for Air Pollution Measurement System, Volume II: Part 1, Ambient Air Quality Monitoring Program, Quality System Development, US EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, (commonly referred to as the "Red Book.").

- Calibration systems will meet 40 CFR Part 50, Appendix D specifications for a Primary Standard Calibration Photometer.
- Calibration systems will be verified against the National Institute of Standards and Technology (NIST) Standard Reference Photometer #10 before use.
- Monitor enclosures will meet the specifications of monitor reference/equivalent designation for temperature control.
- Probes must meet the requirements stated in 40 CFR Part 58 for materials and sample residence time.
- All flow calibrations will be traceable to a primary standard. Flows will be corrected to EPA standard temperature and pressure (25°C and 760 mm Hg).
- Chain-of-custody must be maintained at all times.

Monitoring Procedure

Monitoring will be conducted using the procedure as described, and in accordance with 40 CFR Part 50, APPENDIX A:

- Procedures detailed in the approved instrument manual will be used for installation, calibration, QA checks, maintenance, and repairs.

- Monitors will be calibrated at the beginning and end of each study, and at least quarterly during the study. Calibration procedures detailed in the approved instrument manual will be used for all calibrations.

- Monitors will be calibrated after major maintenance or when a quality assurance (QA) check shows an out-of-control condition exists.

- A zero/span check will be conducted daily on all monitors.

- Precision checks of all monitors will be conducted at least weekly.

- Quality assurance audits as specified in 40 CFR Part 58, Appendix A will be conducted quarterly, or at least once for short duration studies.

- Data telemetry systems will be run in parallel with strip chart recorders. Strip charts will serve as a permanent record and diagnostic tool.

After completion of the study, all monitoring equipment will be returned for inspection, maintenance, and repair prior to storage. All field documentation will be retained by the Air Monitoring Staff.

14.2.2 Monitoring Carbon Monoxide in Ambient Air

The following is a synopsis of procedures which should be strictly adhered to for the monitoring of carbon monoxide in air. This summary is adapted from 40 CFR Part 50, Appendix C - Measurement Principle and Calibration Procedure for The Measurement of Carbon Monoxide in The Atmosphere (Non-Dispersive Infrared Photometry), and The Quality Assurance Handbook for Air Pollution Measurement System, Volume II: Part 1, Ambient Air Quality Monitoring Program, Quality System Development, US EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, (commonly referred to as the "Red Book.").

- Calibration systems will meet 40 CFR Part 50, Appendix C specifications.

- Calibration systems will be verified/calibrated before use in accordance with procedures detailed in the calibration instrument manual.

- Monitor enclosures will meet the specifications of monitor reference/equivalent designation for temperature control.

- Probes must meet the requirements stated in 40 CFR Part 58 for materials and sample residence time.

- All flow calibrations will be traceable to a primary/authoritative standard. Flows will be corrected to EPA standard temperature and pressure (25°C and 760 mm Hg).

- Chain-of-custody must be maintained at all times.

Monitoring Procedure

Monitoring will be conducted using the procedure as described, and in accordance with 40 CFR Part 50, APPENDIX C:

- Procedures detailed in the approved instrument manual will be used for installation, calibration, quality assurance (QA) checks, maintenance, and repairs.

- Monitors will be calibrated at the beginning and end of each study, and at least quarterly during the study.

- Monitors will be calibrated after major maintenance or when a QA check shows an out-of-control condition exists.

- A zero/span check will be conducted daily on all monitors.

- Precision checks of all monitors will be conducted at least weekly.

- Quality assurance audits as specified in 40 CFR Part 58, Appendix A will be conducted quarterly, or at least once for short duration studies.

- Data telemetry systems not equipped with electronic strip chart capability will be run in parallel with strip chart recorders. Strip charts (electronic or paper) will serve as a permanent record and diagnostic tool.

After completion of the study, all monitoring equipment will be returned for inspection, maintenance, and repair prior to storage. All field documentation will be retained by the Air Monitoring Staff.

14.2.3 Monitoring Nitrogen Dioxide in Ambient Air

The following is a synopsis of procedures which should be strictly adhered to for the monitoring of carbon monoxide in air. This summary is adapted from 40 CFR Part 50, Appendix F - Measurement Principle and Calibration Procedure for The Measurement of Nitrogen Dioxide in The Atmosphere (Gas Phase Chemiluminescence), and The Quality Assurance Handbook for Air Pollution Measurement System, Volume II: Part 1, Ambient Air Quality Monitoring Program, Quality System Development, US EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, (commonly referred to as the "Red Book.").

- Calibration systems will meet 40 CFR Part 50, Appendix F specifications.

- Calibration systems will be verified/calibrated before use in accordance with procedures detailed in the calibration instrument manual.

- Monitor enclosures will meet the specifications of monitor reference/equivalent designation for temperature control.

- Probes must meet the requirements stated in 40 CFR Part 58 for materials and sample residence time.

- All flow calibrations will be traceable to a primary/authoritative standard. Flows will be corrected to EPA standard temperature and pressure (25°C and 760 mm Hg).

- Chain-of-custody must be maintained at all times.

Monitoring Procedure

Monitoring will be conducted using the procedure as described, and in accordance with 40 CFR Part 50, APPENDIX F.

- Procedures detailed in the approved instrument manual will be used for installation, calibration, quality assurance (QA) checks, maintenance, and repairs.

- Monitors will be calibrated at the beginning and end of each study, and at least quarterly during the study.

- Monitors will be calibrated after major maintenance or when a QA check shows an out-of-control condition exists.

- A zero/span check will be conducted daily on all monitors.

- Precision checks of all monitors will be conducted at least weekly.

- Quality assurance audits as specified in 40 CFR Part 58, Appendix A will be conducted quarterly, or at least once for short duration studies.

- Data telemetry systems not equipped with electronic strip chart capability will be run in parallel with strip chart recorders. Strip charts (electronic or paper) will serve as a permanent record and diagnostic tool.

After completion of the study, all monitoring equipment will be returned for inspection, maintenance, and repair prior to storage. All field documentation will be retained by the Air Monitoring Staff.

14.2.4 Monitoring Sulfur Dioxide in Ambient Air

The following is a synopsis of procedures which should be strictly adhered to for the continuous monitoring of sulfur dioxide in air. This summary is adapted from the Federal Register equivalent method designation, 40CFR Part 53, and The Quality Assurance Handbook for Air Pollution Measurement System, Volume II: Part 1, Ambient Air Quality Monitoring Program, Quality System Development, US EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC. (commonly referred to as the "Red Book.").

- Calibration systems will meet Federal Register equivalent method specifications.

- Calibration systems will be verified/calibrated before use in accordance with procedures detailed in the calibration instrument manual.
- Monitor enclosures will meet the specifications of monitor reference/equivalent designation for temperature control.

- Probes must meet the requirements stated in 40 CFR Part 58 for materials and sample residence time.

- All flow calibrations will be traceable to a primary/authoritative standard. Flows will be corrected to EPA standard temperature and pressure (25°C and 760 mm Hg).

- Chain-of-custody must be maintained at all times.

Monitoring Procedure

Monitoring will be conducted using the procedure as described, and in accordance with Federal Register equivalent method specification.

- Procedures detailed in the approved instrument manual will be used for installation, calibration, quality assurance (QA) checks, maintenance, and repairs.

- Monitors will be calibrated at the beginning and end of each study, and at least quarterly during the study.

- Monitors will be calibrated after major maintenance or when a QA check shows an out-of-control condition exists.

- A zero/span check will be conducted daily on all monitors.

- Precision checks of all monitors will be conducted at least weekly.

- Quality assurance audits as specified in 40 CFR Part 58, Appendix A will be conducted quarterly, or at least once for short duration studies.

- Data telemetry systems not equipped with electronic strip chart capability will be run in parallel with strip chart recorders. Strip charts (electronic or paper) will serve as a permanent record and diagnostic tool.

After completion of the study, all monitoring equipment will be returned for inspection, maintenance, and repair prior to storage. All field documentation will be retained by the Air Monitoring Staff.

14.2.5 Sampling of Particulate Matter in Ambient Air as $PM_{2.5}$

The following is a synopsis of procedures which should be strictly adhered to for the sampling of particulate matter as $PM_{2.5}$ in air. This summary is adapted from 40 CFR Part 50, Appendix L- Reference Method For the Determination of Fine Particulate Matter as $PM_{2.5}$ in the Atmosphere, EPA Implementation Plan: $PM_{2.5}$ Federal Reference Method Performance Evaluation Program, EPA Quality Assurance Guidance Document 2.12, EPA Quality Assurance Document: Quality Assurance Project Plan for the Performance Evaluation Program, EPA Quality Assurance Guidance Document: Method Compendium, Field Standard Operating Procedures for the $PM_{2.5}$ Performance Evaluation Program, and EPA Quality Assurance Document: Method Compendium, $PM_{2.5}$ Mass Weighing Laboratory Standard Operating Procedures for the Performance Evaluation Program. These documents are available in hardcopy format and as a PDF file on the Ambient Monitoring Technology Information Center (AMTIC) Internet Bulletin Board under the $PM_{2.5}$ QA area (http://www.epa.gov/ttn/amtic/pmqa.html).

- EPA, OAQPS National Filter Distribution Program will send filters to the Regions 4 East Coast $PM_{2.5}$ Filter Weighing Laboratory

- Prior to use the filters will be checked for deformities, equilibrated at 20 - 23 °C ± 2 °C and 30 - 40 % ± 5 % relative humidity for a minimum of 24 hours, labeled, pre-weighed (auto-entry into PEP database), loaded into cassettes, and prepared for packaging and shipping.

- Region 4 Filter Weighing Laboratory will ship the pre-weighed filters and chain-of- custody (COC) forms to the field scientists in Regions 1, 2, 3, 6, and 10.

- Filters and COC forms for Region 4 are passed directly to the field scientists

- After sampling, filters will be transported to the Filter weighing Laboratory, logged into the database, refrigerated until a batch is completed, moved to the laboratory, unloaded from the cassettes, equilibrated for at least 24 hours, and post-weighed.

- Region 4 East Coast Filter Weighing Laboratory will equilibrate and weigh the exposed filters, validate data, and upload information to AIRS.

- Chain-of-custody must be maintained for all samples.

Sample Collection

Samples will be collected using the following:

- Field scientists will take the filters, field data sheets, and COC to the State/local agency monitoring site and setup the portable samplers.

- Air flow, barometric pressure and two temperature measuring devices will be verified prior to each sampling event. All flow, barometric pressure and temperature standard devices are annually calibrated and traceable to a primary standard.

- Internal and external leak checks will be performed.

- Within 8 to 16 hours following the sampling event the exposed filters will be collected and prepared for transport to the Filter Weighing Laboratory.

- Field scientists will return the exposed filter, data diskettes, field data sheets and COC to the appropriate laboratory (as well as keep a set of the data records).

After sample collection, all filters will be stored in petri-slides, boxed, and archived for one (1) year at $\leq 4\,°C$ and two (2) years at ambient room temperature $\leq 25\,°C$.

14.2.6 Sampling of Particulate Matter in Ambient Air as PM_{10}

The following is a synopsis of procedures which should be strictly adhered to for the sampling of particulate matter as PM_{10} in air. This summary is adapted from 40 CFR Part 50, Appendix J - Reference Method for The Determination of Particulate Matter as PM_{10} In the Atmosphere, and The Quality Assurance Handbook for Air Pollution Measurement System, Volume II: Part 1, Ambient Air Quality Monitoring Program, Quality System Development, US EPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC, (commonly referred to as the "Red Book.").

- All filters used will be supplied by the EPA National Filter Distribution Program, and of the same quality as supplied to the State and Local Agency Air Monitoring Stations.

- Prior to use, all filters will be checked for pinholes, and desiccated at 15°C - 30°C ± 3°C, and less than 50 ± 5 percent relative humidity, for at least 24 hours.

- Initial and final (exposed) filter weights will be determined by air monitoring personnel. One of ten filters will be re-weighed as a quality assurance check. For batches less than ten, one filter will be re-weighed.

- After sampling, filters will be desiccated as previously described.

- Chain-of-custody must be maintained for all samples.

Sample Collection

Samples will be collected using the High Volume sampler as described, and operated in accordance with 40 CFR Part 50, Appendix J, and Red Book Sections 2.10, and 2.11.

- All flow calibration orifices will be traceable to a primary standard Rootsmeter. Flows will be corrected to EPA standard temperature and pressure (25°C and 760 mm Hg).

- Digital manometers used for flow rate determinations will be checked against a U-Tube water manometer prior to use in each study.

- Volumetric flow controllers will be used on all PM_{10} samplers. Flows will be determined using a calibrated orifice and a digital manometer.

Integrated Sample Collection

The following procedures should be followed to collect time integrated samples:

- Initial and final flow rates will be determined with a digital manometer and a calibrated orifice.

- After the sample is collected, the filter will be folded lengthwise and placed in a filter holder. The filter holder is then placed in an envelope and the envelope sealed.

- A Chain-Of-Custody Record should be completed detailing the time of sampling and the sampling interval, and should be signed by the person collecting the sample.

After sample collection, all sample envelopes will be placed in an appropriate container. An EPA custody seal will be placed on the container prior to transport to the Region 4 laboratory for final weighing of filters.

14.3 Non-Criteria Pollutant Monitoring for Air pollutants for which National Ambient Air Quality Standards have not been established.

14.3.1 Formaldehyde Sampling With Dinitrophenylhydrazine Cartridges Using Method TO-11A

The following is a synopsis of procedures which should be strictly adhered to for the handling and field use of dinitrophenylhydrazine (DNPH) cartridges for formaldehyde sampling. This summary is adapted from METHOD TO-11A of the COMPENDIUM OF METHODS FOR THE DETERMINATION OF TOXIC ORGANIC COMPOUNDS IN AMBIENT AIR. The following generic procedures should be adhered to at all times.

- Polyethylene, latex, or Nylon gloves must be worn whenever handling any of the DNPH cartridges (in the extraction laboratory, during preparation for shipment, during field set-up, in the field during preparation for return shipment, and in the laboratory during preparation for analysis and during analysis).

- All padding material shall be either clean tissue paper or polyethylene-air bubble padding. Never use polyurethane foam, cardboard, or newspaper as padding material. DNPH cartridges which have been properly prepared for shipment should be shipped in coolers with eutectic salt packs (Blue Ice).

- Chain-of-custody shall be maintained for all samples.

- A minimum of one trip blank shall be transported per one to ten samples collected.

Due to shelf life limitations, only the number of DNPH cartridges needed for a maximum of 180 days (including trip blanks and extra DNPH cartridges for breakage) should be ordered at any one time.

- On the date of shipment or when loading out for a study, the Air Monitoring Staff will remove the capped DNPH cartridges from the refrigerator in the Air Laboratory.

- An appropriate amount of packing material shall be placed in the shipping container to prevent breakage of the glass DNPH tubes. The DNPH tubes should be shipped in coolers containing eutectic salt packs (e.g., Blue Ice) to maintain a temperature of approximately 4°C. The DNPH cartridges shall be shipped the same day they are packed.

- At each sampling location the cooler will be opened and one plugged DNPH cartridge will be removed (wearing clean polyethylene, latex, or nylon gloves) and the two end plugs will be removed from each end of the DNPH cartridge which will be immediately placed on the sampling train. (If it is the SKC brand, the glass ends of the tubes must be broken off. A trip blank will be placed in a sampler enclosure at one of the sites for the duration of the sampling event.

The sampler will be manually turned on and allowed to run for five minutes. An initial flowrate should be recorded on the sample data sheet. The timer should be set to turn the sampler on and off at the desired times.

- The operator should retrieve and secure the sample as soon as possible after the sampling period ends. The sampler should manually be turned on and allowed to run for five minutes and a final flowrate and the elapsed time from the time meter should be recorded on the sample data sheet. The exposed DNPH cartridge will then be removed from the sampling train (wearing clean polyethylene, latex or nylon gloves). The two end caps will be placed on the ends of the DNPH cartridge. The DNPH cartridge will be placed back into the cooler. The same procedure is to be followed at each sampling site.

- At the end of each day on which the samples are collected, the exposed DNPH cartridges shall be either placed in a refrigerator for storage overnight or stored in the cooler. The cooler will be used to transport the samples to the laboratory. The duration of the non-refrigerated period shall be kept to a minimum but absolutely not more than two days (including the sampling event).

Laboratory

Upon arrival of the DNPH cartridges at the laboratory, the samples shall be stored in the a refrigerator until extraction.

14.3.2 Volatile Organic Compounds (VOC) Sampling with SUMMA® Electropolished Stainless Steel Canisters or Silcosteel Canisters Using Method TO-15A

The following is a synopsis of procedures which should be strictly adhered to for the cleanup and use of Summa® canisters for sampling air for Volatile Organic Compounds (VOC) analysis. This summary is adapted from Method TO-15A of the <u>COMPENDIUM OF METHODS FOR THE DETERMINATION OF TOXIC ORGANIC COMPOUNDS IN AMBIENT AIR</u>.

The following procedures must be followed in the preparation and use of Summa® canisters for collecting samples for VOC analysis.

- <u>All</u> new Summa®/Silcosteel® canisters <u>must</u> be individually checked for contamination by the laboratory before use. One of each batch of 10 Summa® canisters that are subsequently cleaned must be analyzed to check for contamination.

- All sampler tubing, fittings, and wetted parts of valves must be solvent washed in hexane and heated to >100° C. These parts should then be assembled and flushed with nitrogen[1] for at least 8 hours prior to use in the sample train or in the canister cleanup apparatus.

- Each canister's valve and fitting will be inspected for damage before cleaning. Any damaged valve will be replaced with a previously cleaned (see procedure above) valve. After replacing any valve, the canister will be cleaned and analyzed to verify that it is free of contamination.

- If any canister is used to sample a high concentration source, it must be cleaned and analyzed to verify it is free of contamination <u>before</u> it can be used again.

- Chain-of-custody must be maintained for all samples.

1. (The nitrogen should be certified 99.999% pure by the manufacturer. A molecular sieve scrubber should be attached to the nitrogen line after the regulator to remove any trace impurities).

<u>Sample Collection</u>

Two types of samples for VOC analysis can be collected with Summa®/Silcosteel® canisters. The canister can be opened and allowed to fill rapidly to obtain a grab sample or filled slowly by using a flow controller to collect a time integrated sample. With either type of sample, the following general procedures should be followed:

- A Chain-Of-Custody Record should be completed detailing time of sampling, sampling interval, and signed by the person collecting the sample.

- After the sample has been collected, the Summa®/Silcosteel® canister should be capped, an EPA pre-numbered tag should be completed and attached to the canister, and the canister should be placed in a shipping container with a copy of the Chain-Of-Custody Record and sealed with EPA sample custody tape.

<u>Grab Sample Collection</u>

Before a grab sample is collected for VOC analysis in a Summa®/Silcosteel® canister, the canister inlet valve should be fitted with a pre-cleaned stainless steel particulate filter. At the sample collection location, the main valve should be opened and the canister allowed to fill. After about one minute (when no audible sound of rushing gas can be heard), the main valve of the Summa® canister should be closed and capped.

Time Integrated Sample Collection

This sample collection method involves the use of a flow controller or a sampler containing a flow controller to slowly meter the flow of air entering a Summa®/Silcosteel® canister. With this method, a sample is collected over a longer period of time than with a grab sample. If a constant flowrate was maintained, the resulting sample will have a VOC content that is the average of the VOC concentrations during the sampling interval.

The following procedures should be followed to collect time integrated samples:

- Cleaning and Adjustment
  All sampler systems should be checked for contamination prior to use or after any major repair. This is accomplished by metering zero air or nitrogen[1] to the inlet of the sampler. Excess zero air or nitrogen should be vented with a Swagelok® tee from the sampler inlet to atmosphere. The evacuated canister should then be filled at the normal sampling rate with the zero gas and verified by the laboratory to be free from contamination.

- Sample Collection
  Prior to sampling the flow controller will be calibrated a mass flow meter. The flowrate should be adjusted so that at the end of the sampling interval the ending pressure of the canister is approximately 0.9 atm. The final canister vacuum should be between 5 inches and 1 inch of Hg. The final flowrate should be at least 1 scc/min.

After sample collection, all canisters should be tagged with an EPA pre-numbered tag with all of the information filled out. Place the canister in a shipping container and seal the container with EPA sample custody tape.

14.3.3 Sampling for Semi-Volatile Organic Compounds (SVOC) Analysis with High Volume PUF Samplers Using Methods TO-4A & TO-13A

The following is a synopsis of procedures which should be strictly adhered to for use of the High Volume Polyurethane Foam (PUF) sampling method for collecting samples for semi-volatile organic compound (SVOC) analysis including pesticides and polychlorinated biphenyls. This summary is adapted from Method TO-4A (pesticides and PCBs) and TO-13A (polynuclear aromatic compounds) of the COMPENDIUM OF METHODS FOR THE DETERMINATION OF TOXIC ORGANIC COMPOUNDS IN AMBIENT AIR.

The following procedures must be followed during preparation of PUF sampling media when using the High Volume PUF method for collecting samples for SVOC analysis:

- All PUF sampling media should be pre-cleaned, loaded into High Volume PUF sample cartridges, and sealed in solvent washed cans by the extraction laboratory prior to use.

- Chain-of-custody shall be maintained for all samples.

PUF Cleaning

The Air Monitoring Staff has responsibility for buying the PUF media and cutting the PUF plugs. PUF media should be specified as not containing any fire retardants. It should be stored in the dark to prevent photo-oxidation. It should be less than two years old, and should be stored in a pesticide free environment.

Care should be exercised in cutting the PUF. It should be thoroughly wet with tap water prior to cutting. A drill press and stainless steel PUF cutting die should be used. The drill press area should be free of oil and a polyethylene cutting block should be used to stop the die at the bottom of the drill press stroke (do not use wood). Water should be sprayed on the die to help prevent snagging as the PUF is cut. After the plugs are cut, they should be rinsed with tap water and followed by a rinse with analyte-free water. Finally, the excess water should be squeezed out.

The PUF/XAD cartridges are assembled using a modified glass sleeve containing an extra-extra coarse frit to retain the XAD resin in the following manner. A 3/4-inch layer of XAD resin is poured on top of the frit followed by a 1½-inch PUF plug to retain the XAD resin.

The assembled PUF/XAD cartridges are delivered to the extraction laboratory for cleaning and checking. The extraction laboratory will be given a minimum of three weeks notice for cleaning and checking the PUF/XAD cartridges. The cleaned PUF/XAD cartridges should be wrapped in aluminum foil and packed in metal cans cushioned by new polyethylene bubble wrap to prevent breakage during shipment. Prepared PUF/XAD sample cartridges that are pre-packed in solvent washed metal cans will be obtained from the extraction laboratory prior to sampling. The cans should be packed inside coolers frozen eutectic salt packs (Blue Ice) to maintain a temperature of less than 15 °C.

<u>Sample Collection</u>

The following procedures will be followed for all High Volume PUF/XAD sampling.

Latex gloves will be used when handling all PUF/XAD cartridges and quartz particulate pre-filters. Assure that the red silicon upper and lower gaskets, located in the cartridge housing, are in place. Then remove the PUF/XAD cartridge from the shipping can, remove from the foil and insert the cartridge into the High Volume sampler's chamber. The pre-filter should be installed in the filter holder using caution not to over tighten the fittings. The foil should be placed back in the shipping can. The can should be labeled with site ID, operators name, and sample date, and placed in the High Volume sampler enclosure until the sample is collected.

The High Volume sampler should be turned on and allowed to run for two minutes. An initial flowrate should be recorded on the sample data sheet. The timer should be set to turn the sampler on and off at the desired times.

The operator should retrieve and secure the sample as soon as possible after the sampling period ends. The sampler should then be manually turned on and allowed to run for two minutes. A final flowrate should be recorded on the sample data sheet. The final flowrate should be at least 150 liters per minute. The PUF/XAD cartridge should be removed, and the quartz pre-filter folded and placed in the <u>top</u> of the PUF/XAD cartridge. The PUF/XAD cartridge and pre-filter should be re-wrapped in the original aluminum foil and placed back in the shipping can. The can should then be tightly sealed. Complete the sample data sheet and Chain-Of-Custody Record and seal the shipping can with a sample custody seal. Finally, the shipping can containing the sample should be placed in a cooler containing frozen eutectic salt packs (at a nominal temperature of ~ 15° C). When all samples are collected from all sites, the cooler should be sealed with sample custody tape for transport back to the laboratory.

<u>Laboratory</u>

Upon arrival of the metal container at the laboratory, the samples shall be stored in the metal container in a refrigerator until submitted for extraction.

14.3.4 Collecting Samples for Metals Analysis Using the High Volume Sampler

The following is a synopsis of procedures which should be strictly adhered to for the collection of samples for metals analysis in air. This summary is adapted from 40 CFR, PART 50, APPENDIX B - Reference Method For The Determination Of Suspended Particulate Matter In The Atmosphere (High Volume Method), and 40 CFR, PART 50, APPENDIX G - Reference Method For The Determination Of Lead In Suspended Particulate Matter Collected From Ambient Air.

The following procedures must be followed in preparation for collecting samples for metals analyses with the High Volume sampler.

- All quartz filters used will be supplied by the EPA National Filter Distribution Program, and of the same quality as supplied to the State and Local Agency Air Monitoring Stations.

- Prior to use, all filters will be checked for pinholes, and desiccated at 15°C - 30°C, ± 3°C, and less than 50 percent relative humidity, ± 5 percent, for at least 24 hours.

- A filter field blank will be taken to the field, but not exposed. Filter field blanks will be analyzed by the laboratory to determine the concentration of metals contained in the filter matrix. The number of filter blanks will be determined based on a minimum of one blank for each ten samples collected.

- Chain-of-custody must be maintained for all samples.

Sample Collection Procedures

Samples will be collected using the High Volume sampler as described, and operated in accordance with 40 CFR, PART 50, APPENDIX B:

- All flow calibration orifices will be traceable to a Primary Standard Rootsmeter. Flows will be corrected to EPA standard temperature and pressure (25°C and 760 mm Hg).

- Digital manometers used to determine flow rates will be checked against a U-Tube water manometer prior to use in each study.

- Air Monitoring Staff personnel will remove a 2-inch strip of the exposed filter from one end and discard it. Two 1-inch strips will be cut from the same end and transported to the laboratory for analysis.

Integrated Sample Collection

The following procedures should be followed to collect time integrated samples:

- Initial and final flow rates will be determined with a calibrated orifice and a digital manometer.

- After the sample has been collected, the filter will be folded lengthwise and placed in a filter holder. The filter holder is then placed in an envelope and the envelope sealed.

- A Chain-Of-Custody Record should be completed which contains the time of sampling, the sampling interval, and the signature of the person taking the sample.

After sample collection, all sample envelopes will be placed in an appropriate container. An EPA custody seal will be placed on the container. Filters will be cut by the Air Monitoring Staff and transported to the laboratory for analysis.

14.3.5 Standard Operating Procedure for Mercury Analysis of Air Using the Tekran Mercury Vapour Analyzer model 2537A.

The following is a synopsis of procedures which should be strictly adhered to for continuous monitoring of gaseous mercury in ambient air.

Instrument operation

The Tekran Vapour Analyzer 2537A is designed to "continuously" analyze air for total gaseous mercury. The Tekran 2537A uses Cold Vapour Atomic Fluorescence Spectrophotometry (CVAFS) for the detection of mercury. In addition to being much more sensitive than atomic absorption, CVAFS is linear over a much wider range and not as subject to positive interferences. The design of the 2537A minimizes the likelihood of negative interference. The adsorption step uses a patented pure gold matrix as the adsorbent. This material is highly specific to mercury, eliminating interferences. The instrument has been shown to be linear from 0.1 ng/M^3 to ~1500 ng/M^3.

Although the instrument can handle samples with high concentrations, the user must avoid exposing the instrument case and parts to high levels of mercury. Mercury contamination residing on the instrument's components could skew both analyses and calibrations.

References

1) The Tekran Vapour Analyzer 2537A User Manual

2) The Tekran Model 2505 Mercury Vapour Calibration Unit User Manual

Procedure

The Tekran Vapour Analyzer 2537A continuously samples ambient air for gaseous mercury. It performs the analysis periodically as determined by the method entered by the operator into the on-board computer. The frequency of analysis (and thus the duration of the sample collection) can be varied from about every 4 minutes to 15 minutes. The analysis begins when air is drawn into the instrument through the Sample Air Inlet. The instrument's on board computer switches a set of valves that introduces sample into one of two gold matrix cartridges at a time. As the sample passes through the cartridge, the mercury in the air amalgamates onto the encased gold mesh screen. While one cartridge samples the air, the onboard computer analyzes the other cartridge. At the start of the analysis cycle, the instrument sweeps the cartridge with argon gas, then heats the cartridge. Mercury that was adsorbed onto the gold matrix is released during heating in argon. The mercury is then swept into the detector by the flow of the argon carrier gas. U.V. light at 253.7 nm excites any mercury atoms present, which fluoresce and re-radiate at the same wavelength. A UV detector views the cell at right angles to the incident light. Direct light from the source is not seen, however, the fluorescence produced by the mercury in the cell is observed by the UV detector. The intensity of the fluorescence is directly proportional to the amount of mercury in the cell. Once the mass of mercury present is known, the on-board computer calculates the concentration of mercury as the mass of mercury divided by the volume of air sampled. The on-board computer sends the analysis results to a display screen and to a data-collecting computer. Although the instrument switches between chambers instantaneously, the analysis of the mercury within the chamber and calculations involved require an unavoidable lag time before the results are available. When the instrument is used for onsite sampling/analysis, the analyst must take care to link the readout to the appropriate sample.

Safety

The instrument itself presents few Health & Safety concerns. However, the instrument is typically used in areas where mercury contamination is suspected. The individual responsible for sampling the air should use personal protective equipment (PPE) stipulated by the site safety officer. The manufacturer includes a tube filled with activated charcoal that can be placed on the vents to absorb the mercury vented from the instrument. The mercury lamp emits UV radiation; never look directly into the lamp, and avoid exposing skin and eyes to the UV rays.

Interferences

Due to the unique design of the Tekran, there are no known chemical interferences. The only materials that enter the instrument are gases and vapors, and the only material that is retained by the gold screen is mercury. All other materials pass through the cartridge. The mercury is desorbed and analyzed with no other materials present to interfere with the fluorescence detection.

Required Equipment

- The Tekran 2537A

- The Tekran Model 2505 Mercury Vapor Calibration Unit. This item is used only at the SESD base laboratory. Although this item is transportable, movement can disrupt the internal mercury bead. If any of the internal mercury adheres to the syringe during calibration, the actual amount of mercury present in the sample will be drastically underreported, leading to an inflated response factor.

- Teflon® prefilter. A 5μ 47mm Teflon® prefilter should be used on the inlet end of the sample line to prevent contamination of the sample line from the inlet to the instrument. The instrument has two additional 47mm Teflon® filters on its ambient air inlet and the zero air inlet.

- ¼" O.D. Teflon® tubing. The tubing is used to collect the sample and should be long enough to reach the most distant sample location, but not longer than 100 feet.

- A computer to record the data. (Must be capable of running in DOS mode and running the Telix data capture program supplied by Tekran).

- A scrubber tube filled with activated carbon, to attach to the vents.

- 10, 25 or 50µL syringes. The syringes should be gas tight, with Teflon® tipped barrels. Tekran recommends using syringes with side venting needles because they are less likely to plug on extracted septum material. Read the User's Manual to learn how to condition the syringes for use with the primary standard.

Reagents & Standards

- High Purity Argon to act as the carrier gas.

- Compressed zero air or high purity Nitrogen to act as the Zero Air.

- Elemental Mercury (<5ml) for use in the Tekran 2505 Cold Vapor Calibrator as a primary standard.

Calibration

A mercury permeation tube is housed in a temperature control chamber within the Tekran 2357A for routine calibration of the instrument. This tube is maintained at 50 °C. The permeation tube constantly emits mercury at a low rate that does not vary as long as the temperature remains stable and as long as there is carrier flow over the permeation tube. This mercury can be directed to the cartridges and sets the response factor of the instrument automatically. The analyst can initiate an internal calibration in three different ways. First, the method for the on-board computer can be programmed to start the calibration at a specific time. Next, the analyst may use the keyboard to start the calibration from two different operating modes. Finally, the instrument will start a calibration when an electric circuit switch on the back panel is closed from a remote device.

The permeation rate of the mercury permeation tube is only constant once the permeation tube has reached a constant temperature and has reached equilibrium. Upon instrument startup, the calibration source should be allowed to stabilize for 12-hours with power applied and carrier gas connected before a calibration is attempted. Typically, the method stored in the on-board computer will be set to perform one calibration per 24-hour period following this warm up period. Different study requirements may require different calibration intervals.

The User's Manual provides much more detail than this document. The analyst should read and understand the manual for a complete description of the calibration process. The automated calibration is initiated using the front panel control. The steps are outlined as follows:

- From the **MAIN MENU** screen, use the arrow keys to highlight **CALIBRATE** and press **<Enter>** to start the calibration.
- From the **CALIBRATE MENU** screen, highlight **TYPE** and press **<Enter>**
- Select the **SOURCE** option
- From the **CALIBRATE MENU** screen, highlight **CALIB** and press **<Enter>**
- From the **CALIBRATE CYCLE** screen, highlight **FULL** and press **<Enter>**
- From the **CALIBRATE:CALIB** screen, highlight **BOTH** and press **<Enter>**

It is important to routinely verify the permeation rate of the Tekran 2357A's internal permeation tube. A manual calibration procedure must be performed to certify the internal permeation rate. The manual calibration procedure utilizes the well documented vapor pressure of mercury to produce a "primary standard". When elemental mercury is enclosed in a sealed chamber at a fixed temperature, it reaches equilibrium and a gaseous concentration of mercury of fixed concentration is present. The amount of mercury contained per unit volume at a given temperature is a well known function that is available in tables. To simplify this calibration, the Tekran model 2505 mercury vapor calibration unit is used. It is typically operated at 15 °C (it should be maintained at least two degrees below ambient to prevent condensation of mercury on the syringes)

The User's Manual provides much more detail than this document. The analyst should read and understand the manual for a complete description of the manual calibration process. The manual calibration is initiated using the front panel control. The steps are outlined as follows:

- From the **MAIN MENU** screen, use the arrow keys to highlight **CALIBRATE** and press **<Enter>** to start the calibration.
- From the **CALIBRATE MENU** screen, highlight **TYPE** and press **<Enter>**
- Select the **INJECT** option and press **<Enter>**
- From the **CALIBRATE MENU** screen, highlight **CALIB** and press **<Enter>**
- From the **CALIBRATE CYCLE** screen, highlight **FULL** and press **<Enter>**
- From the **CALIBRATE: CALIB** screen, highlight **BOTH** and press **<Enter>**

The calibration begins with the Clean Cartridge A cycle, and proceeds to the Clean Cartridge B cycle, followed by the Zero Cartridge A, Zero Cartridge B, Span Cartridge A, and finally Span Cartridge B cycle. During the Span cycles, the instrument will prompt the analyst when it is time to inject the primary standard. The amount of standard required is calculated and preset during method development. After a successful calibration, the instrument will calculate the results for both cartridges, including their Blank Correction (Blcorr) and Response Factor (Respfctr). The operator should ensure that the response factor does not change more than ±10% between calibrations or corrective maintence may be necessary. Now the instrument is ready to measure samples.

Analysis & Operation

Once the instrument is calibrated, the operation is straightforward. From the main menu screen, highlight **RUN** and press **<Enter>**. The instrument will start sampling and analyzing the air following the method stored in memory. The results are displayed on screen, but can also be sent to an attached computer.

Calculations

The instrument's on-board processor calculates the concentrations automatically. The user need not perform any calculations during routine sampling and analysis.

Flowrate checks

The sample flowrate of the Tekran is controlled by an electronic mass flow controller which in turn is controlled by the on-board computer. Since the mercury permeation tube used to calibrate the instrument emits a constant mass of mercury per unit time, changes in sample flowrate won't always be apparent during calibrations. However, changes in flowrate would result in direct errors in the quanitation of the ambient air samples. So, it is important to periodically check the flowrate to verify that the electronic flow controller is working properly. Sample flowrate is best checked against a primary flow calibrator such as a soap-film bubble meter or a positive displacment calibrator such as a Dry Cal®. The calibration is conducted by attaching the calibrator to the inlet and measuring the flowrate. If the flowrated doesn't match the flowrate stated on the instrument display, the mass flow controller should be recalibrated as per the Tekran manual.

Records Management & Documentation

The data sent to the attached computer will stored for on the computer but backup copies of the data should be placed onto removable discs and stored for record keeping.

14.3.6 Sampling for Dioxin And Dibenzofuran Analyses with High Volume PUF Samplers Using Method TO-9A

The following is a synopsis of procedures which should be strictly adhered to for use of the High Volume Polyurethane Foam (PUF) sampling method for collecting samples for polychlorinated dibenzo-p-dioxins and dibenzofurans analyses. This summary is adapted from Method TO-9A of the COMPENDIUM OF METHODS FOR THE DETERMINATION OF TOXIC ORGANIC COMPOUNDS IN AMBIENT AIR.

Since this method requires High-Resolution Mass Spectrometry which the Region 4 laboratory does not have, all sample media preparation and analysis will have to be contracted. At least one month's notice prior to sampling should be given to obtain a contract laboratory program (CLP) contract for any dioxin and dibenzofuran analysis. It is important that the contract specify a number of details to assure accurate results:

- All of the PUF media and a representative number of each batch of quartz pre-filters should be checked by the contract laboratory to assure that there is no contamination. Each PUF plug should be pre-spiked by the contract laboratory with dioxin and dibenzofuran surrogates as a check of the accuracy of the method.

- Each set of PUF plugs and quartz filters should be securely packed in sealed containers and in coolers to prevent damage during shipment. The sampling media should be shipped air freight to minimize the time between cleanup and sampling.

- Chain-of-custody shall be maintained for all samples.

Sample Collection

The following procedure will be followed for the collection of all High Volume PUF samples for dioxins and dibenzofurans analyses.

Nylon or latex gloves will be used when handling all PUF cartridges and quartz particulate pre-filters. Assure that the red silicon upper and lower gaskets are in place in the PUF cartridge housing. Remove the PUF cartridge from the shipping can. Unwrap and insert the PUF cartridge into the High Volume (Hi-Vol) PUF sampler's chamber. Install the pre-filter in the filter holder using caution not to over tighten the fittings. The removed aluminum foil should be placed in the shipping container which then should be resealed. The container should be labeled with the site ID, the operators name, and the sample date, and placed in the Hi-Vol PUF sampler enclosure until the sample is collected. The Hi-Vol PUF sampler should be turned on and allowed to run for two minutes. An initial flowrate should be recorded on the sample data sheet. The timer should be set to turn the sampler on and off at the desired times.

The operator should retrieve and secure the sample as soon as possible after the sampling period ends. The sampler should then be manually turned on and allowed to run for two minutes and a final flowrate recorded on the sample data sheet. The final flowrate should be at least 150 liters/minute. The PUF cartridge should be removed, and the quartz pre-filter folded and placed in the top of the PUF cartridge. The PUF cartridge and pre-filter should be re-wrapped in the original aluminum foil and placed back in the shipping container and the container should be tightly sealed. Complete the sample data and sample custody sheets. Each shipping container should have a sample custody seal. Finally, the shipping container containing the sample should be placed in a cooler containing frozen eutectic salt packs (at a nominal temperature of ~ 4° C). When all samples are collected from all sites, the cooler should be sealed with sample custody tape for shipment to the contract laboratory.

Contract Laboratory

Upon arrival of the metal container at the contract laboratory, the samples shall be stored in the metal container in a refrigerator until submitted for extraction.

14.3.7 Mercury Sampling Using Gold-Coated Glass Bead Tubes

The following is a synopsis of procedures which should be strictly adhered to for the handling and field use of gold-coated glass bead mercury sampling tubes.

The following generic procedures should be adhered to at all times.

- Polyethylene, latex or Nylon gloves must be worn whenever handling any of the mercury sampling traps (in the laboratory, during preparation for shipment, during field set-up, in field during preparation for return shipment, and in the laboratory during preparation for analysis and during analysis).

- Pre-cleaned mercury sampling traps which have been prepared for longer than 60 days shall not be used.

- Chain-of-custody shall be maintained for all samples.

- A minimum of one trip blank shall be transported one per ten samples collected.

Laboratory

Upon completion of preparation of the mercury sampling traps, both ends shall be plugged with Teflon male plugs, the plug connection wrapped in Teflon tape, and each trap placed in a plastic shipping tube. A serial number, expiration date, and a lot number label will be placed on each shipping tube. The batches of shipping tubes shall be placed in sealed lock-top plastic containers.

Air Monitoring Staff

The Air Monitoring Staff will notify and keep the laboratory informed as to the anticipated number of prepared mercury sampling traps needed for field use. On routine studies, the Air Monitoring Staff will notify the laboratory of needs at least two weeks in advance of needed pick-up date. Only the number of mercury sampling traps needed for a maximum of 60 days (including trip blanks and extra sampling traps for breakage) will be requested.

- On the date of shipment or when loading out for a study, the Air Monitoring Staff will remove the sealed plastic containers (which contain the mercury sampling traps sealed in plastic shipping tubes) from the Air Laboratory.

- An appropriate amount of packing material shall be placed in the shipping container to prevent breakage of the mercury sampling tubes.

- On each sampling date, the plastic container(s) will be removed from the refrigerator or cooler for transport to the field. At each sampling location the plastic container will be opened and one mercury sampling tube will be removed (wearing clean polyethylene or nylon gloves). The end plugs will then be removed from each end of the mercury sampling trap which will be immediately placed on the sampling train. The end plugs will be placed back into the shipping tube and the cap placed on the tube wrapped in Teflon® tape. The shipping tubes will be left in the sealed plastic container. The same procedure will be adhered to at each sampling location. A trip blank will be opened, handled, and resealed at one site to evaluate potential passive contamination.

The sampler will be manually turned on and allowed to run for two minutes. An initial flowrate should be recorded on the sample data sheet. The timer should be set to turn the sampler on and off at the desired times.

- Air monitoring personnel should retrieve and secure the sample as soon as possible after the sampling period ends. The sample pump should be manually turned on and allowed to run for two minutes, and a final flowrate and the elapsed time from the elapsed time meter should be recorded on the sample data sheet. The exposed mercury sampling trap should then be removed from the sampling train wearing clean polyethylene or nylon gloves. The two end caps shall then be removed from the shipping tube and placed on the ends of the sampling trap. The sampling trap will be placed back into the shipping tube, the lid tightened, and placed back into the plastic container. The same procedure must be followed at each sampling site.

- At the end of each study, the samples will be transported to the laboratory.

14.3.8 Standard Operating Procedure for Chlorofluorocarbon (CFC) Refrigerant Field Screening using the Neutronics Model RI-2002PA Portable Automotive Refrigerant Identifier and liquid CFC sample collection.

The Neutronics Model RI-2002PA is designed to identify vapor gas samples taken directly from CFC refrigerant storage cylinders. The Neutronics Model RI-2002PA 2537A uses Multiple Sensor, Non-Dispersive Infrared (NDIR) technology to perform the analysis.

The Neutronics Model RI-2002PA 2537A identifies the percentage, by weight, of R12, R134a, R22 and hydrocarbons (HC) in a sample of refrigerant. The unit will flash the measured percentages of R12, R134a, R22 and HC on the display if their concentrations are greater than zero. Samples will be identified with air concentrations up to 90% by weight. The Neutronics Model RI-2002PA 2537A eliminates the effect of air when determining the concentration of a gas because air is not considered a contaminate and can be removed during the recycling process. The instrument detects and indicates either R12 orR134a if the sample is at least 98 % pure. The Neutronics Model RI-2002PA has an accuracy of ± 1 % the concentration of contaminates in the 0-5 % range and ± 2 % the concentration of air after a 30 minute warm-up period. If a hydrocarbon refrigerant is detected in a mixture sufficient to constitute a potential flammability problem, a horn will sound and a hydrocarbon LED will light.

The instrument is designed to sample gas concentrations. If the liquid phase is sampled by mistake and contains lubricating oil the pre-filter will turn red and the instrument may need to be returned to the manufacturer for repair.

References

The Neutronics Model RI-2002PA Portable Automotive Refrigerant Identifier Operation & Instructions Manual

Field Screening Procedure

The operator of the Neutronics Model RI-2002PA should be familiar with the detailed procedures as described in the Neutronics Model RI-2002PA Portable Automotive Refrigerant Identifier Operation & Instructions Manual. The following Quick Instructions are from page 9 of the manual and give a brief description of how to operate the instrument.

1. Read and follow the Safety Messages on pages 3 and 4 of the Neutronics Model RI-2002PA Portable Automotive Refrigerant Identifier Operation & Instructions Manual

2. Connect the correct hose (R12 or R134a) to the RI-2002PA Sample Inlet. DO NOT connect the service end of the hose to the cylinder at this time.

3. Plug the power cord into a three prong standard wall outlet (110/220 vac 60/50 Hz.).

4. After warm and auto cal, connect the supplied calibrated sample hose to the vapor port of the cylinder.

5. 9-15 psig will register on the system pressure gauge. The unit is ready to take a sample as indicated by the flashing green LED. Push the *ENTER* button. Wait for the identification mode.

6. The RI-2002PA will indicate a *PASS* status with an R12 or R134a LED, or *FAIL* status with a fail LED and the detected refrigerant concentrations . The display will scroll through and indicate the percent by weight concentrations for R12, R134a, R22 and HC if their concentrations are not zero. If the gas is determined to be potentially flammable , the hydrocarbon LED will illuminate and the horn will sound. Press the Horn Mute button to silence the horn, and follow the safety messages.

- After Identification, a flashing yellow LED will indicate that the unit is ready to purge. DISCONNECT THE SAMPLE HOSE FROM THE CYLINDER. Be sure the system pressure gauge registers 0 psig, and press the *ENTER* button. Allow the unit to purge then connect the hose to the next cylinder. Go to Quick Instructions Step2.

Safety

The instrument itself presents few health & safety concerns. However, the instrument is used to sample refrigerant containers that have internal pressures exceeding 150 psi. The refrigerants may cause skin or eye injury from low temperature, if allowed to vent. The individual responsible for sampling should use personal protective equipment (PPE) stipulated by the site safety officer.

Interferences

Due to the unique design of the Neutronics Model RI-2002PA, there are no known chemical interferences. The only materials that enter the instrument are gases and vapors. The instrument will analyze and report the presence of hydrocarbons and water.

Required Equipment

- The Neutronics Model RI-2002PA 2537A
- Calibration Standards
- Spare Disposable Filter Assembly (Neutronics part # RI-2002PA1)
- Parallel Port Printer to record the data
- Appropriate fittings

Calibration

The RI-2002 PA is factory tuned and does not require any further adjustments in the field. The instrument also features automatic self calibration. However, the instrument's calibration is verified by analyzing R-12, R-22 and R-134a standards. Standards are run in the same fashion as a sample. The standard is followed by a room air purge to verify the system is cleaning itself after a high concentration of analyte. Standards for air and hydrocarbons are not analyzed.

Calculations

The instrument's on-board processor calculates the concentrations automatically. The user need not perform any calculations during routine sampling and analysis.

Records Management & Documentation

The instrument will only store data from the last analysis performed. Therefore, to maintain a hard-copy record of sampling runs the data will be sent to the printer and will immediately be printed out.

Liquid CFC Sampling

The following is a synopsis of procedures which should be strictly adhered to for the cleanup and use of canisters for sampling refrigerants for analysis. This summary is adapted from Method TO-15A of the COMPENDIUM OF METHODS FOR THE DETERMINATION OF TOXIC ORGANIC COMPOUNDS IN AMBIENT AIR.

- All new canisters must be individually checked for contamination by the laboratory before use. One of each batch of 10 canisters that are subsequently cleaned must be analyzed to check for contamination.

- All sampler fittings, must be solvent washed in hexane and heated to >100° C. These parts should then be assembled and flushed with nitrogen[1] for at least 8 hours prior to use in the sample train or in the canister cleanup apparatus.

- Each canister's inlet port fitting will be inspected for damage before cleaning. Any damaged fitting will be replaced with a previously cleaned (see procedure above) fitting. After replacing any fitting, the canister will be cleaned and analyzed to verify that it is free of contamination.

- Chain-of-custody must be maintained for all samples.

1. (The nitrogen should be certified 99.999% pure by the manufacturer. A molecular sieve scrubber should be attached to the nitrogen line after the regulator to remove any trace impurities).

Sample Collection

The canister is connected to the liquid port of the refrigerant container. NOTE: Some refrigerant containers will need to be rolled or inverted to collect a liquid sample depending on their construction.

- Connect the pre-evacuated sampling canister to the refrigerant container using the appropriate tubing (e.g. 1/4 inch outside diameter, thick wall, Teflon® tubing) and fittings.

- Open the sampling canister valve.

- Slowly open the refrigerant valve. Verify liquid CFC flowing through the tubing. Fill the sampling canister approximately one-half full. Close the refrigerant container valve while the sampling canister is still filling. Then close the canister sampling valve. This will prevent CFCs venting during the sampling process.

- After the sample has been collected, the canister should be capped, an EPA pre-numbered tag should be completed and attached to the canister, and the canister valve sealed with EPA sample custody tape.

- A Chain-Of-Custody Record should be completed detailing time of sampling, refrigerant container identification and signed by the person collecting the sample.

- The samples are returned to the SESD laboratory for analysis.

SECTION 15
FIELD PHYSICAL MEASUREMENTS

SECTION OBJECTIVE:

- Present the standard practices used for making field physical measurements;

15.1 Introduction

Field measurements of topographic features, water levels, time-of-travel, geophysical parameters, physical dimensions, etc., are frequently required during field investigations conducted by the Branch. The purpose of the investigation will determine the scope of these measurements.

All sampling locations used during field investigations should be depicted on an accurate drawing, topographic or other standard map, or be referenced in such a manner that the location(s) can be firmly established. The Region 4 library has a complete collection of 7.5 minute USGS (1:24,000 scale) topographic maps and a map copier is available.

Each field measurement made should be traceable to the person(s) making the measurement and to the field equipment used to make that measurement. Equipment maintenance and calibration records shall be kept in log books and field records so that the procedures are traceable. Time records shall be kept in local time using the hour format, with the time recorded to the nearest five minutes or less.

New employees should perform each of the physical field measurements described in this section under the supervision of a senior technical staff member at least once before being permitted to make these measurements on their own.

15.2 Horizontal Location Surveys

15.2.1 Introduction

Surveying is described as the art and science of determining the area and configuration of portions of the earth's surface, and representing them on maps. Generally, surveying can be divided into two categories or classes: horizontal control surveying and vertical control surveying. Horizontal control surveying pertains to the measurement of the relative difference in the horizontal location of two or more control points. Vertical control surveying involves the measurement of the relative difference in vertical location, or elevation, of two or more control points and is treated separately in Section 15.3. This Section discusses the standard procedures, techniques, and methods used to survey, or locate sample points or site features horizontally. Basic surveying and field geology textbooks should be consulted for more detailed information on this topic (See References 1, 2, and 3).

Several field methods, from traditional or classical methods to Global Positioning System (GPS) techniques, may be used to horizontally locate sample points or various site features during site investigations. Traditional traverse methods utilize horizontal angle or direction (azimuth/bearing) measurements and calculated horizontal distances from a starting point to a second point, and from the second to the third, and so forth to the last point. The last point in a traverse is usually a return to the starting point, thus making a closed loop. During a traverse for site control, sample points or site features may be located by employing various techniques at the traverse control points, i.e., by angle (azimuth or bearing) and distance measurements from a control point, by angular intersection from two control points, by perpendicular offset from a line between two control points, by angle from one control point and distance from another control point, etc.

GPS methods utilize radio frequency measurements with multichannel receivers of the signals from the global network of satellites that the US Department of Defense has established. Measurements of the horizontal sample locations or site features by GPS technology is actually based on the same principles used in traditional surveying methods. However, with space-based GPS, hand held receivers and data loggers measure the distances to three or more noncoincident points or satellites of known positions and triangulate the position of the sample location, site feature or point on earth. More fundamental information on GPS technology may be found in Reference 4.

Regardless of the method(s) used, horizontal location surveys should be based on established control points. A network of horizontally (and vertically) located control points has been established and is continually maintained by the National Oceanic and Atmospheric Administration (NOAA) through its National Geodetic Survey (NGS) (formerly U.S. Coast and Geodetic Survey and National Ocean Survey). The old horizontal datum, called the North American Datum of 1927 (NAD27), is currently being replaced with the newer datum of 1983 (NAD83). The NAD27 system of horizontal control points, have established geographic latitude and longitude positions, and provided the basis for the State Plane coordinate grid systems used by many States. If the original geographic positions or coordinates are from the old NAD27 datum, then the resulting positions or coordinates should be converted to the new NAD83 datum. The official computer program, developed by the NGS, to convert latitude/longitude from the old NAD27 to the new NAD83 is called NADCON. Another program that is useful is CORPSCON which converts between coordinates and latitude/longitude from both NAD27 and NAD83 (it has NADCON built in as a subroutine).

When measuring horizontal angles, compensation should be made for the angle between true north and magnetic north. This angle is called the magnetic declination. Field surveying methods should be referenced to true north. The first step in this procedure is to determine from an isogonic map, the declination for the area of work. Isogonic maps may be found in basic surveying and field geology textbooks referenced above.

Sources of existing information on horizontal control stations or coordinate grid data and their "exact" locations may be obtained from local, state or federal departments or agencies. However, the best place to obtain a horizontal control point data, is from the website www.ngs.noaa.gov . Typically, the engineering or public works departments of counties, cities or towns may have data on file that is near the particular site being investigated. Several state or federal agencies which are also good sources of useful data include:

- State highway or transportation departments
- State geodetic or land surveying offices
- State natural or water resources bureaus
- State geological surveys
- NOAA/National Geodetic Survey
- United States Geological Survey
- Corps of Engineers, Department of the Army
- Soil Conservation Service
- Tennessee Valley Authority
- Bureau of Land Management

When the exact locations of sampling points or other physical features at a site are needed, surveying methods must be based on existing control data. If necessary, the site property boundary survey, legal description, and any physical property corners or monuments must be located by a professional Registered Land Surveyor (RLS). Often, before or when the surveyor is at a site, the registered surveyor could be requested to set control data points for latter use. At a minimum, the registered land surveyor would be asked to establish at least two control points upon which the elevation and the State Plane coordinates are set. The data on control points shall be of at least third-order accuracy. The control points will be permanent markers set at locations that are unlikely to be disturbed by future site activities.

If no existing control data exists in the site vicinity, two arbitrary points may be established at a permanent location, e.g., set a nail or spike beneath the ground or set a nail and cap in asphalt or foundation. The point where the instrument is first set should be the starting point and it is recommended that the arbitrary coordinates for this point be 10,000 north and 10,000 east or (10000,10000). This is so all other points relative to the starting point will hopefully, be positive. Note that when listing points such as 10000,10000 or latitude and longitude that the order is usually y,x or northing and eastings. Also recall, from geometry, that movement to the north or east is in a positive direction. The second arbitrary point, called the back sight, should be tied or referenced to a bearing or azimuth so the other points will truly be spatially relative. However, the coordinates for those points (and, therefore all other points) should be determined at a later date. As with all field work, the location of all control data used and all field measurements shall be recorded in the field logbook as outlined in Section 3.5.

15.2.2 Equipment Available

The following equipment is available for field use in conducting horizontal surveys in support of site investigations:

- Topcon GTS-2, total station theodolite/electronic distance meter (EDM)
- Trimble Pathfinder Pro XR 12 channel or Geoexplorer II GPS receivers
- tripod(s)
- reflector prism(s)
- prism pole
- steel tape
- cloth tape
- right angle prism
- compass

15.2.3 Specific Equipment Quality Control Procedures

All field surveying methods using the above equipment shall be made only by those personnel who have been trained to use them. All professional staff and field technicians must be trained and checked out in surveying procedures by qualified staff before using this equipment.

Each piece of field equipment (as appropriate) shall be numbered, and a log book shall be kept containing all maintenance and calibrations made on the equipment. The following specific maintenance and calibration procedures shall be used for all surveying equipment:

Theodolite -- This equipment shall:

- be serviced and calibrated by a qualified private service shop annually or sooner if damaged or suspected to be in error;

- be checked out using procedures outlined in basic surveying textbooks and appropriate users manuals before use (See References 1, 2, and 3); and,

- be cleaned and maintained using procedures outlined in basic surveying textbooks and appropriate users manuals during field use and before being returned to storage (See References 1, 2, and 3).

GPS Receivers – This equipment shall:

- be serviced and calibrated by the manufacturer if damaged or suspected to be in error; (See References 4 and 5).

- be checked out using procedures outlined in the appropriate users manuals before use; (See References 4 and 5); and,

- be cleaned and maintained using procedures outlined in the appropriate users manuals during field use and before being returned to storage (See References 4 and 5).

Steel and Cloth Measuring Tapes – The following procedures shall be used for all measuring tapes:

- All measuring tapes will be calibrated against an Invar steel surveyors chain or the theodolite/EDM both of which are traceable to the National Bureau of Standards (NBS). Those steel tapes that are not within 0.01 foot per 100 feet or cloth tapes not within 0.02 foot per 100 feet shall be discarded.

- Tapes shall be checked to see that they are not damaged and are clean before and after use.

Compass -- All compasses shall:

- be checked for proper movement of the compass needle. If the compass needle movement is sluggish, the glass cover can be removed by prying a knife point under the spring washer. The copper wire on the needle is then moved until the needle lies level (Reference 3);

- be checked for proper alignment of clinometer level. The clinometer is checked by setting the clinometer to 0, and placing the compass on a surface that has been leveled exactly with either a carpenters level or a water tube level. If the horizontal level bubble on the clinometer does not rest at the center, the compass is opened as described above and the clinometer level vial is moved and rechecked as appropriate. If the level vial becomes broken, the compass must be sent to the manufacturer to be repaired (Reference 3); and

- be cleaned after use and before storage. If the compass should become wet, the compass is opened as previously described and the interior is dried using a toothpick and a piece of soft cloth or soft paper. They should not be used, exposed to or stored in strong electrical fields (Reference 3).

Prism Poles and Reflector Prisms -- All of this equipment shall:

- be checked for warpage and/or damage before use by sighting through the theodolite/EDM while the poles/prisms are rotated in two planes at 90° intervals. The bulls eye bubble will be reset as appropriate; and

- be cleaned daily after use and before being returned to storage.

15.2.4 Procedures for Traversing

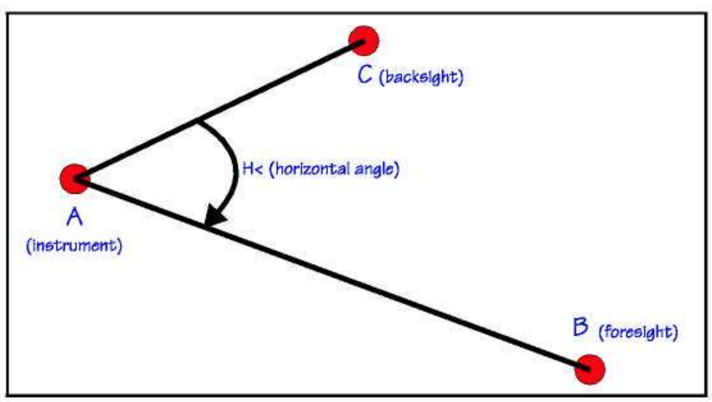
When traverse methods are used, at least two stations or control points of known horizontal location (expressed in terms of an arbitrary, local, State Plane or Universal Transverse Mercator coordinate system) must be in the site vicinity. These horizontal control points can usually be set for the specific site by a governmental agency or registered land surveyor.

The total station theodolite, often called the instrument, measures horizontal angles, vertical and/or zenith angles, and slope distances, is set up over an existing control point. The theodolite is attached to the plate of the tripod by a fastening screw and the bubble in the bullseye level is centered, or brought level by adjusting the three-screw leveling heads appropriately. Once the bulls eye bubble is centered, the theodolite is rotated 90 degrees at a time and the horizontal level bubble is checked and brought level using the three-screw leveling heads. The instrument is ready for use when, after repeated rotations, the bubble in the horizontal level remains exactly in the center or middle of its housing.

The rodman has either a range pole equipped with a reflector prism (single or triple) or a tripod with the reflector prism. The prism is used to reflect the signal from the electronic distance meter in the total station theodolite. While located over the point(s) whose location is desired, the rodman holds the range pole vertically by means of centering the bulls eye bubble, or sets up the tripod and reflector prism similarly as stated above. The instrument man sights through the telescope on the theodolite, lines up the horizontal and vertical cross-hairs on the center of the prism and records the horizontal angle (H∢), vertical angle (V∢) or zenith angle (Z∢), and the slope distance (Ds) to the prism. The difference in location between the point where the theodolite is set up and the point where the prism is held is determined trigonometrically. A compass and measuring tape could also be used to reference field measurements to a map or vice versa.

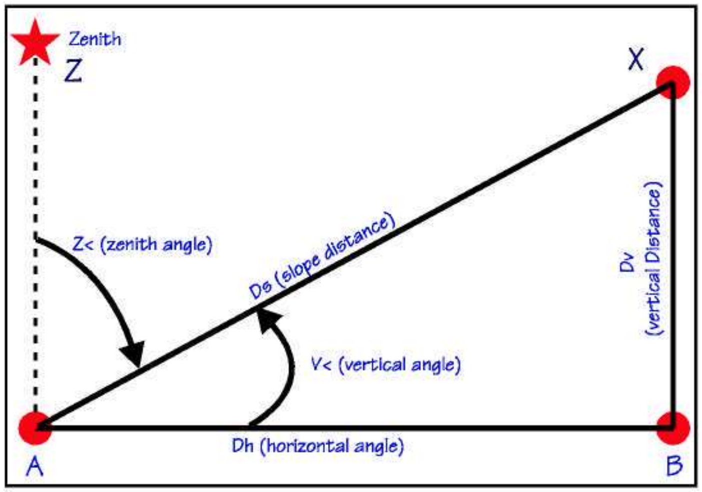
The following examples depict some of the field measurements that must be considered and accounted for, the calculations that must be performed, and the conversions that must be made when traverse methods are used to horizontally locate sampling points or other site features.

EXAMPLE 1, Horizontal Angles: Figure 15.2.1 illustrates that while the instrument is at point A (a control point), one reads the back sight angle (azimuth or bearing) to point C, then turns and measures the foresight angle (azimuth or bearing) to point B. The difference between the two angles is the interior angle included at the intersection of line AC and line AB, or the horizontal angle (H∢). The field notation for the measurement of the angle above would be represented as angle C-A-B. Typically, the first column to the left in the field book is labeled: (BS - ╤ - FS), which stands for Backsight - Instrument - Foresight, or the column will simply be labeled Station and the second column is labeled H∢ (see Example 5, Field Notation).



Example 1: Figure 15.2.1. Map view showing horizontal angle C-A-B.

EXAMPLE 2, Vertical or Zenith Angles: After the horizontal angle is determined, the vertical angle (V∢) is measured, in Figure 15.2.2, from point B to point X to determine the angle between the line of sight AX and the horizontal line AB. The vertical angle is the included angle between a line connecting two points of different elevations and a line horizontal to the earths gravity. The vertical angle in Figure 15.2.2 is above the horizontal line AB and is also called an angle of elevation or positive angle and the field notation should be preceded by a + sign. If the vertical angle is below the horizontal line AB, it is called an angle of depression or negative angle and the field notation should be preceded by a - sign. Note that most theodolites measure the adjacent zenith angle instead of the vertical angle. A zenith angle is simply the included angle between a line connecting the point exactly overhead and the point in question. For example: a zenith angle of 90° is a horizontal line or right angle and the complimentary vertical angle would be 0°. The vertical angle can be obtained by subtracting the zenith angle from 90°.



Example 2: Figure 15.2.2. Side view showing vertical angle B-A-X and zenith angle Z-A-X.

To determine the height of the point X, measure the slope distance (Ds) with the electronic distance meter from A to X. Using the theodolite or transit, measure the vertical angle between line AX and AB or the zenith angle. The height of point X would be obtained by the appropriate trigonometric formula:

Dv = (sin V∢) Ds
or
Dv = (cos Z∢) Ds

The horizontal distance (Dh), which is the distance used when drawing the map, would be obtained by the appropriate formula:

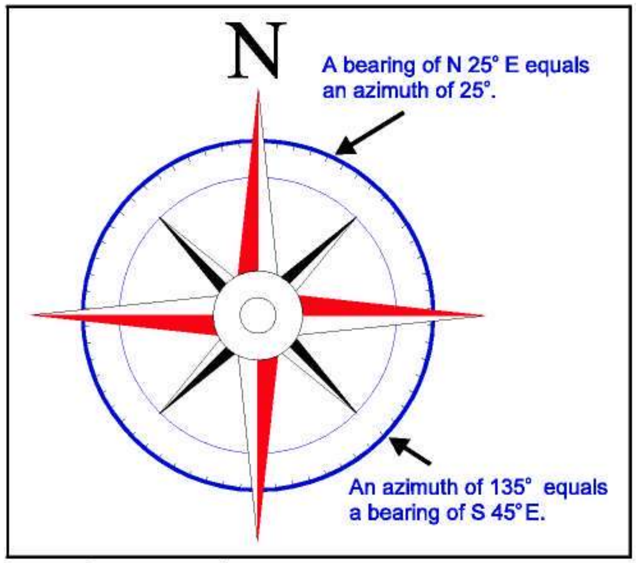
Dh = (cos V∢) Ds
or
Dh = (sin Z∢) Ds

If the vertical distance to be measured was to the top of a building, tank, or other point where the measurement of the slope distance is impractical, simply measure the horizontal distance and determine the height by:

Dv = (tan V∢) Dh

The field notation for the third column from the left in the field book is labeled: Z∢ or V∢ and the forth column is labeled Ds/Dh (see Example 5 Field Notation).

EXAMPLE 3, Azimuths and Bearings: When surveying, personnel should be able to convert bearings to azimuths or azimuths to bearings as shown in Figure 15.2.3. An azimuth is an angular direction based on the compass rose which divides a circle into 360°. The direction of northeast is expressed as an azimuth of 45°. Its reciprocal azimuth or the southwest azimuth direction is 225°. An azimuth is always turned clockwise from north or 0°. A bearing is the direction turned, either clockwise or counter-clockwise, with respect to north or south (whichever is closer) on a compass. As a bearing, the direction of northeast is expressed as North 45° East, while its reciprocal, or reverse bearing, is expressed as South 45° West.



Example 3: Figure 15.2.3. Compass rose showing conversion between azimuths and bearings.

The following are examples of conversions:

BEARING TO AZIMUTH		AZIMUTH TO BEARING	
N25°E	25°	135°	S45°E
S15°E	165°	280°	N80°W
N89°53'57"W	270°06'03"	353°06'49"	N06°53'11"W
S10°18'W	190°18'	06°35'	N06°35'E

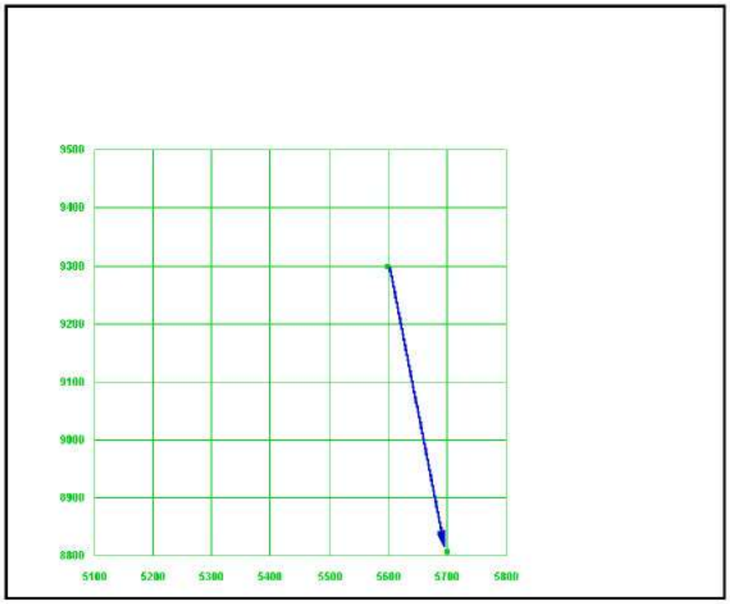
EXAMPLE 4, Coordinates: When the local State rectangular grid coordinate points near a particular site are obtained, personnel should be able to convert rectangular coordinates to polar coordinates. This is important since through this conversion, the azimuths and distances between each point can be obtained and then used as the starting control points for the site control traverse. Computers or simple programmable or non-programmable calculators are extremely useful in providing precise results from the field surveying measurements. The following is an example of manual conversion from rectangular to polar coordinates:

The instrument is set up at JORDAN88, and, given the rectangular coordinates:

Control Point	North (y)	East (x)
JORDAN88	9302.24	5605.23
SONIA93	8811.19	5706.13

The relative change in location between the north and east coordinates (from JORDAN88 to SONIA93), respectively, are:

$\Delta N = -491.05$ $\quad\quad$ $\Delta E = 100.90$



Example 4: Figure 15.2.4. Map view showing change in direction from JORDAN88 to SONIA93.

The negative symbol for ΔN indicates the relative movement from JORDAN88 to SONIA93 downward (-) along the y axis (Figure 15.2.4.). The positive symbol for ΔE indicates relative movement from JORDAN88 to SONIA93 to the right (+) along the x axis. Solving for the formula (Pythagorean theorem):

$$c^2 = a^2 + b^2$$

The resulting distance between JORDAN88 and SONIA93 is c = 501.31'.

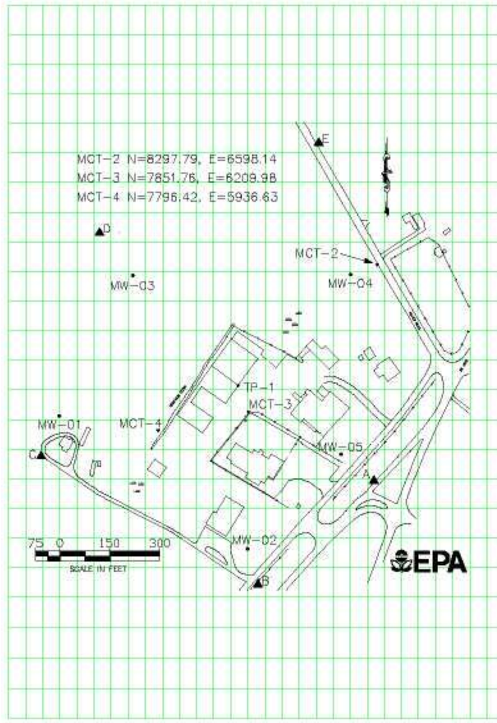
The azimuth is obtained by first computing the inverse tangent of the change in north divided by the change in east:

$$\tan^{-1} (\Delta N \div \Delta E) = -78.3886°$$

This is the negative angle, expressed in decimal degrees, and is measured from the (x) axis into the southeast quadrant. The azimuth from JORDAN88 to SONIA93 is obtained, in this case, by changing the sign (- to +) and adding 90° which would give 168.3886 degrees. Converting to degrees, minutes, and seconds is the next task and the degrees are already done. Since there are 60 minutes in one degree, take the .3886 degrees and multiply by 60 and obtain 23.3160 minutes. Likewise there are 60 seconds in one minute, take the .3160 minutes and multiply by 60 and obtain 18.96 seconds. The resulting azimuth from JORDAN88 to SONIA93 is 168°23'19". **Note: The trigonometric formula above always gives the angle measured from the east-west (x) axis.** When using this procedure, it is wise to make a sketch, as shown above, (Figure 15.2.4.) that indicates the change in direction between the points relative to north. This will aid in visually and mentally seeing which geometric quadrant that the foresight angle falls in relation to the instrument. If the inverse tangent result was positive and pointed in the northeast quadrant direction, the azimuth would be subtracted from 90° and converted to degrees, minutes, and seconds. Likewise, when the inverse tangent result points in the southwest quadrant direction, the negative angle would be subtracted from 270° and a positive inverse tangent result pointing in the northwest quadrant would be added to 270° and then converted to degrees, minutes, and seconds.

EXAMPLE 5, Traverse Field Notation: The following is an example of the field notation for a traverse to horizontally locate sampling points. Figures 15.2.5 and 15.2.6 show the field notation, on the left hand side of the field log book and the physical features, sampling points, and traverse control points sketched on the right hand side of the field log book. The coordinates for each point are determined and usually entered in red ink after the traverse is finished.

02/01/96	Project 96E-0001 Region 4 Site Name City, State		Landis Surveyor - + Ben Chmark - ϕ Weather: Clear; 0-5 mph N	
Set traverse points around property to locate 5 monitoring wells				
Given:	TP1: MCT2: MCT3: TP1 to MCT3 :	N=7935.07 N=8297.79 N=7851.76 ΔN=-83.32	E=6178.78 E=6598.14 E=6209.98 ΔE=31.21	
	[illegible]	33.3		
	[illegible]	[illegible]		
	∴ Azimuth TP1 to MCT3 = 159 27'54"			
(BS- + -FS) Station	H<	Z<	Ds / Dh	Coordinates
MCT3-TP1-	Set:H< = 159°27'54"	90° 45'24"	88.98' 88.97'	N=7935.07 E=6178.78
MCT3-TP1-A	125°26'18"	89° 44'06"	502.64' 502.635'	N=7643.63 E=6588.30
MCT3-TP1-MW5	124°09'12"	90° 07'21"	375.58' 375.58'	N=7724.22 E=6489.59
TP1-A-	Set:H< = 305° 26'18"	---------------		
TP1-A-B	228° 00'54"	90° 32'54"	470.94' 470.94'	N=7328.60 E=6238.24
A-B-	Set:H< = 48° 00'54"	---------------		
A-B-MW2	343° 55'21"	90° 21'54"	113.68' 113.68'	N=7437.83 E=6206.76
A-B-C	300° 46'27"	89° 59'54"	762.46' 762.46'	N=7718.72 E=5583.14
B-C-	Set H< = 120° 46'27"	---------------		
B-C-D	14° 40'24"	89° 49'39"	698.34' 698.34'	N=8394.28 E=5760.03
B-C-MW1	24° 11'21"	90° 21'12"	132.96' 132.96'	N=7840.01 E=5637.62
B-C-MW3	26° 50'36"	89° 44'45"	612.76' 612.754'	N=8265.45 E=5859.83



Example 5: Figure 15.2.5. Traverse field notation with site map showing traverse points used to locate monitoring wells.

02/01/96	Project 96E-0001 Region 4 Site Name City, State		Landis Surveyor - + Ben Chmark - ø Weather: Clear; 0-5 mph N	
(BS- + -FS) Station	H<	Z<	Ds / Dh	Coordinates
C-D-	Set:H <= 194°40'24"	---------------		
C-D-E	67°36'15"	90°03'48"	715.66' 715.66'	N=8666.95 E=6421.71
C-D-MW3	142°17'51"	89°45'03"	163.14' 163.14'	N=8265.20 E=5859.80
D-E-	Set:H <= 247°36'15"	---------------		
D-E- MCT2	154°27'09"	90°04'33"	409.08' 409.08'	N=8297.87 E=6598.13
E-MCT2-	Set:H <= 334°27'09"	---------------		(N=8297.79) (E=6598.14)
E-MCT2-A	180°51'42"	89°36'24"	654.28' 654.265'	N=7643.60 E=6588.30
E-MCT2-MW4	249°56'39"	88°32'48"	85.66' 85.63'	N=8268.42 E=6517.70
MCT2-A-	Set:H <= 360°51'42"	---------------		
MCT2-A-TP1	305°26'18"	---------------	-------- (502.635')	N=7935.04 E=6178.78
MCT2-A-MW5	309°13'33"	91°10'36"	127.50' 127.47'	N=7724.21 E=6489.55

Example 5 (continued): Figure 15.2.6. Second page of traverse field notation.

15.2.5 Procedures for Differential GPS

Differential GPS involves the use of two or more multichannel receivers. One or more are used as the rover receiver(s) and usually only one is used as the base station. The base station and the rover(s) should be within 200 to 300 miles of each other in order to increase the accuracy of the measurements (accuracy increases as separation between base and rover decreases) and have a clear view of the sky. The base is set up on a control point of known horizontal location (usually expressed in terms of latitude, longitude and elevation).

Trilaterated coordinate positions from the satellites are recorded at the base, which will be compared to the actual horizontal control point coordinates for the development of a correction factor to be applied to other roving GPS units. Since the base station receiver and the rover receiver(s) synchronize with the satellite's clocks, data must be recorded or logged by both receivers at the exact same time in order for the correction factor to be applicable. Often times, base station data will be obtained via modem, disk or internet after the field data collection by the rovers. It is therefore extremely important to coordinate the logistics and planning for using GPS techniques before leaving for the field (See Reference 4).

The procedures to follow when using GPS to locate horizontal positions of site features are quite simple and relatively easy to conduct. The GPS receiver/data logger is turned on and a predefined point, line or area feature to be mapped is selected from a data dictionary within the data logger. Once the feature is logged, the receiver/data logger user closes the feature, moves to the next feature for logging and so forth until all site features are logged. The data files are then downloaded, differentially corrected, if necessary, and exported to GIS applications for mapping and display of the features logged. Navigation to predefined points (called waypoints) is accomplished by selecting the waypoint from within the data logger, and proceeding in the direction displayed in the data logger until you arrive at the waypoint desired.

However, depending on which GPS receiver/data logger is used (Pathfinder Pro XR or Geoxplorer II), different types of GPS processing measurements can be made: Code Pseudorange or Carrier Phase. With these different processing measurements comes different accuracy. When code pseudorange is employed, the autonomous position measurements (without differential correction) will be within about 10 meters using either receiver/data logger listed above. When code pseudorange is used with differential GPS (this is either real time or post processed), the position measurements will be less than 1 meter for both the Pathfinder Pro XR or Geoexplorer II. Note: the Pathfinder Pro XR is capable of real time differential GPS (i.e., it has a beacon receiver built in), while the Geoexplorer II is not. When carrier phase is employed, both receiver/data loggers can obtain sub meter accuracy for points to be logged only (not waypoint navigation), and it is necessary to occupy each point feature a minimum of 5 minutes. So, although the basic procedures are simple and easy, some thought must be put into the planning of the data collection effort in order to define the features to be logged, capitalize on the accuracy and to meet the objectives of the project.

All professional staff and field technicians must be trained in the use of the GPS equipment by qualified staff before using this equipment. Specific procedures on the operation and setup of the GPS equipment are described in detail in the operations manuals for each of the instruments. All instruments will be used consistent with the instructions contained within these manuals. A copy of each of the manuals will be maintained by a designated person within the Region. The following templates list the methods and procedures to be considered and performed if differential GPS procedures will be used to data log GPS positions or horizontally locate sampling points or other site features (See Reference 5).

TEMPLATE 1. Planning To Capture GPS Data.

- ❑ Training in the use of GPS equipment is critical to the success of a field project.
- ❑ The objectives and accuracy requirements should be established and factors that might limit the use of the GPS equipment should be assessed.
- ❑ Check the availability of the GPS equipment and test it prior to going in the field in order to ensure that it works properly and meets the requirements of the field project.
- ❑ Decide what features (points, lines, or areas) and their attributes at a site that locational information will be captured with GPS equipment and create a Data Dictionary on the PC with Pathfinder Office software. Transfer the Data Dictionary to Asset Surveyor on the Data logger.
- ❑ Check the availability of horizontal control point data at or near the site for GPS equipment precision and accuracy check. If none exists, remember to log at least four points that surround the site and that can be seen in aerial photographs or topographic maps for checking and GIS georeferencing.
- ❑ Check the availability of base station coverage if the project is not dependant on collecting real time data.

TEMPLATE 2. Creating A New Data Dictionary.

- ❑ In Pathfinder Office software on the PC select *Data Dictionary Editor* from the *Utilities* menu.
- ❑ Select *New* to generate a new dictionary.
- ❑ Enter the name of the new data dictionary, and any comments (optional), then click *Ok*.
- ❑ Select *New Feature*. Enter the name of the feature and under *Feature Classification* choose *Point, Line* or *Area* depending on what the feature is on a map, then click *Ok*.
- ❑ Select *New Attribute*. Enter the type of attribute *Menu, Numeric, Text, Date, Time, File Name* or *Separator,* click *Ok* and fill in the requested *Attribute Name* information, click *Ok,* then click *Close* when finished with that attribute.
- ❑ Add more features and attributes as necessary. Many attributes can be listed for one feature. Attributes can be menus, numbers, character strings, dates or times. Numeric values require a minimum, maximum, and default value. Character strings require a maximum string length. Dates and times can be set for automatic generation in the field.
- ❑ Consider putting features that are most commonly used at the beginning of the dictionary and any existing GIS database that may require specific character string lengths. At the end of all data dictionaries that are created, a *generic point, line,* or *area* is also generated. This is in case while in the field, a feature not listed in the data dictionary may be tagged and identified. The following is an example of the data dictionary used by the region.

"COC_GIS", Dictionary, "Chain of Custody/GIS Data Dictionary"

"Surfsoil", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Subsoil", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Potwater", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Muniwsupply", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Indwell", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Waste", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Surfwater", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Sediment", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Groundwater", point
  "Sample_ID", text, 30
  "Station_ID", text, 30

"Precipitation", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Other_unknown", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Other_biota", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Munipwater", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Indprocwater", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Wipesample", point
"Sample_ID", text, 30
"Station_ID", text, 30

"FIshsample", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Vegetation", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Macroinvertibrates", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Wastewater", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Sludgenonrcra", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Uicinjectionwells", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Petrotanks", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Ambair", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Indoorair", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Munieffwater", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Indeffwater", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Periphyton", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Tissue", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Lithology", point
"Sample_ID", text, 30
"Station_ID", text, 30

"Fence", line
"Type", text, 30

"Road", line
"Name", text, 30

"Railroad", line
"Name", text, 30

"Stream", line
"Name", text, 30

"Structure", area
"Type", text, 30

TEMPLATE 3. Data Dictionary Transfer To Data Logger or Geoexplorer II.

- ❑ Connect the GPS unit to the COM1 port of the PC using the appropriate cable that is attached to the COM1 port of the data logger or in the case of the Geoexplorer II attached to the input port.
- ❑ Select *File Transfer* in the data logger Asset Surveyor software main menu, or *Data Transfer* in the Geoexplorer II main menu.
- ❑ In Pathfinder Office software on the PC, select *Utilities*, then *Data Transfer*. Note: *Device* should be set to *GIS Data logger* and *Data Type* should be set to *Data Dictionary*. Under *Available Files*, highlight the data dictionary name and under *Selected Files*, choose *Add*. Under *Direction*, choose *Send*. Then click *Transfer*.
- ❑ Once the data dictionary has been transferred, *Close* the *Data Transfer* window and exit the data logger or Geoexplorer II.
- ❑ Note: Several data dictionaries can be uploaded to a data logger, but only one can be uploaded to a Geoexplorer II. Subsequent uploaded data dictionaries to the Geoexplorer II will delete previous ones.

TEMPLATE 4. Default Configuration Of The Data Logger And Geoexplorer II For Data Capture.

- ❑ In Asset Surveyor software on the data logger, choose *Config* or *Configuration* in the Geoexplorer II and set the following.

Logging Intervals

Point Feature	1 second
Line and Area Feature	5 seconds
Not in Feature	All
Velocity	All
Minimum Positions (point feature)	20 (data logger) 120 (Geoexplorer II)
Position Mode	Overdet. 3D (data logger)ODS 3D (Geoexplorer II) Note: Manual 3D is the minimum for both.
Elevation Mask	15° (data logger and Geoexplorer II); 10° (base)
Signal-to-noise ratio mask	6 (data logger); 5 (Geoexplorer II)
PDOP mask and switch	6
Dynamics Code	Land (for terrestrial work), Sea or Air (for obvious reasons)

Template 5. Data Capture File Name Convention.

- ❑ Default file name convention is recommended.
- ❑ Assists with identifying files by time and date for matching up base station file if differential correction is needed.
- ❑ The following describes the parts of a file with the name: A021514A

GPS UNIT	MONTH	DATE	HOUR (UTC)	FILE LETTER
A	02	15	14	A

- ❑ When multiple GPS units are at the same site data logging, each unit will be given a different letter identification.
- ❑ UTC stands for Universal Time Coordinated, which used to be known as Greenwich Mean Time (GMT), i.e., the local time at the Greenwich meridian (zero degrees longitude). For the conversion between Eastern Standard Time (EST) or Eastern Daylight Time (EDT), use the following formula.

EST = UTC - 5 hours	(note that this is fall and winter)
EDT = UTC - 4 hours	(spring and summer)

Template 6. Data Capture Logging And Considerations.

- ❑ Choose *Data Capture* from the main menu.
- ❑ Select *Create rover file* in the data logger (choose *Open Rov. File* in the Geoexplorer II) or *Reopen rover file* when appending to a previous file.
- ❑ The *Create* file screen has three fields: *File, Data Dict.* and *Free Space*. Press Enter on the *Data Dict* field to choose your data dictionary.
- ❑ Press *Ok* to start the current file selected.
- ❑ Scroll through *Start feature* in the data logger or scroll to *Select Feature* in the Geoexplorer II and press Enter. A list of features in the data dictionary associated with the current file is displayed.

- ❑ Select the appropriate feature by pressing Enter. Then type the appropriate attribute value(s).
- ❑ After the minimum number of positions are attained (see Template 4 above), press *Ok* to accept and store the feature and all of its attributes values (in the Geoexplorer II, scroll to *Close Feature* to accept and store the feature and all of its attributes).
- ❑ Proceed to the next site feature and continue this operation for all site features. Note that while collecting positions for one feature, for example the positions along a road, you can *Nest* other features, for example wells or other sample points on one side of the road or the other, then press *Ok* to accept and store the wells or other sample points feature and attribute values and continue logging the road. When finished, press *Esc* to exit *Data Capture* and return to *Main Menu* (in the Geoexplorer II, scroll to *Close File* and select *Yes* to return to *Main Menu).*

CONSIDERATIONS

- ❑ Check the horizontal control point data at or near the site for GPS equipment precision and accuracy. To obtain a nearby National Geodetic Survey (NGS) control point, search the website www.ngs.noaa.gov and click "NGS Products and Services" then go into "Data Sheets" until "NGSmap" is found. This is an interactive NGS data sheet retrieval tool that will produce a map of up to 32 control points near the site. Use the data sheets to find the horizontal control point and record a separate point generic feature data file at the control point as a check of the manufacturers specifications for the GPS unit.

- ❑ When collecting GPS locational information, keep in mind the available maps or areal photographs of the site. Note: The GIS group has electronic georeferenced coverage of most of the region with USGS Topographical Maps or Aerial Photography. One of the best websites to obtain aerial photographs of a site is: http://rsori.rtpnc.epa.gov/ which is EPA's remote sensing home page. If only maps are available, collect enough site feature information to improve the existing maps. Collect at least four GPS points surrounding the site that can be seen in the field and on the existing maps and/or areal photographs (intersections of roads, manhole covers, etc.) so the existing maps and/or areal photographs can be georeferenced and rectified to the same coordinate system, datum, and projection back in the office with GIS techniques.

Template 7. Data Logger Files To PC.

- ❑ Connect the data logger to COM1 of the PC using the appropriate cable that is attached to the COM1 port of the data logger, or, in the case of the Geoexplorer II, attached to the input port.
- ❑ In Pathfinder Office software on the PC, select the appropriate project, then *Utilities,* then *Data Transfer.* Note: *Device* should be set to *GIS Data logger* and *Data Type* should be set to *Data.* Under *Available Files,* highlight the files to be downloaded and under *Selected Files,* choose *Add* or *Add All*
- ❑ Under *Direction* choose *Receive.* Then click *Transfer.* The data file(s) will be converted to files with a .ssf extension.
- ❑ Once the data files have been transferred, *Close* the *Data Transfer* window and exit the data logger.

Template 8. Differential Correction.

- ❑ If a real time GPS unit was used for data capture, the data file(s) must be checked to see if all positions were differential corrected through the real time broadcast signal. If any portion of a data file was not corrected with the real time broadcast signal, a base station file must be obtained in order for all positions in the file to be differentially corrected.

- ❑ In Pathfinder Office software on the PC, select *File* then *Open.* Select the data file(s) to look at then *Ok.* After a brief scan of the features, one by one, identify the features and file name(s) that need a base station file for differential correction then *Close* the file(s).
- ❑ Obtain base station file(s) from a base station as close to the site as possible and that match the month, date and UTC hour of the data file(s) exactly and place in the Base subdirectory of the Project directory in Pathfinder Office software on the PC (C:\Pfdata\(Project)\Base). These can be obtained through modem, internet, email, or disk via regular mail. As in Template 5 with data files, the base station files use a similar file naming convention and will identify the month, date, and UTC hour that the base station file was collected. The following is the base station file naming convention.

CITY	YEAR	MONTH	DATE	HOUR (UTC)
A	9	02	15	14

- ❑ These websites are good starting points for base station files and cover our entire region:

  http://www.ngs.noaa.gov/CORS/cors-data.html
  http://www.fs.fed.us/database/gps/clickmap/cbsmap.htm
  ftp://ftp.dep.state.fl.us/pub/

- ❑ Once base sation files are obtained that match the month, date, and UTC hour, in the data files as indicated above (and also in the same year), in Pathfinder Office software on the PC, select *Utilities* then *Differential Correction.*
- ❑ Select the rover file(s) (more than one may be selected) to be differentially corrected. If the base station files were placed in the Base subdirectory as mentioned above, select *Local Search* and the base station files that match the data files will be highlighted. Select *Ok.*
- ❑ The differentially corrected files will be placed in the Project directory with a .cor extension and the processing should be set to *Smart Code and Carrier Phase Processing.* After all of the above procedures are followed, select *Ok* to start the differential correction process.
- ❑ To view the corrected files, select *File* then *Open* and the corrected files should be highlighted. Select *Ok* to view then scan through the features to make sure all positions were differentially corrected.

Template 9. Export to ARC/INFO Arcview GIS.

- ❑ In Pathfinder Office software on the PC, select *Utilities,* then *Export.*
- ❑ Select the *Input Files* for export (highlighted).
- ❑ By default the *Output Folder* where files are exported is C:\Pfdata\(Project)\Export.
- ❑ In *Choose an Export Setup,* select *Sample Arcview Shapefile Setup* then click *Properties.*
- ❑ Data: Type of data to export: *Features - Positions and Attributes* and pulldown *Export All Features.*
- ❑ Position Filter: Filter by GPS Position Info; Minimum Satellites: *3d (4 or more Svs),* Maximum PDOP: *Any,* Check *Realtime Differential* and *Differential.*
- ❑ Output: Output Files *Combine all input files and output to the project export folder* and System File Format *DOS Files.*
- ❑ Coordinate System: Use export Coordinate System: *Latitude/Longitude,* Datum: *NAD 1927 (Conus).*
- ❑ Attributes: Export Menu Attributes As: *Attribute Value,* Generated Attributes: check *Feature Name.*
- ❑ Arcview Shapefile: Theme Options: Skip this screen.
- ❑ Units: Use Export Units: *Change,* then select the appropprioate units (metric or english).
- ❑ Select *Ok* when finished with *Change Setup Options,* then *Ok* to export.

- ❑ Three types of files are generated. Each named feature, (where *feature* is one of the features listed in the Data Dictionary that was created in Template 2) will have the extensions: .dbf, .shp, and .shx.
- ❑ Transfer all of the *.dbf, .shp, and .shx* files to the appropriate directory on the R4ESD LAN G:\user\shared\ drive so they may be transfered by FTP or other means to the appropriate directory and work space in the GIS UNIX boxes. The GIS group (on their UNIX Boxes) or Project Leader (on the PC) will use these files in Arcview. Any conversions between coordinate systems and datums that may be necessary should be done by the GIS group.
- ❑ Open Arcview and add the coverages as themes.

Template 10. GIS to Realtime Differential GPS Waypoint Navigation.

- ❑ After the collection of site features, (i.e., wells, site structures, roads, etc), with GPS techniques, and/or after the site areal photographs or maps are georeferenced and rectified, specific samples locations can be picked out of the GIS coverages, and generated into waypoints. These waypoints can then be transferred back into the realtime GPS Data logger and used to layout a soil sampling grid or other locations of interest at the site.
- ❑ Waypoint files created in ARC/INFO must be in the following ASCII format for importing into Pathfinder Office software on the PC: xcoordinate,ycoordinate,zcoordinate,"waypointnameornumber" Note: the zcoordinate is optional and may be left blank with a space (i.e., x,y,,"waypoint").
- ❑ Once waypoint files are generated and in the proper format, in Pathfinder Office software on the PC, select *File, Waypoints,* then *ASCII Import.* Select the waypoint file to be imported and click *Ok.*
- ❑ Next, connect the GPS unit to the COM1 port of the PC using the appropriate cable that is attached to the COM1 port of the data logger.
- ❑ Select *File Transfer* in the data logger Asset Surveyor software main menu.
- ❑ In Pathfinder Office software on the PC, select *Utilities*, then *Data Transfer.* Note: *Device* should be set to *GIS Data logger* and *Data Type* should be set to *Waypoints.* Under *Available Files,* highlight the waypoint file name and under *Selected Files,* choose *Add.* Under *Direction,* choose *Send.* Then click *Transfer.*
- ❑ Once the waypoint file has been transferred, *Close* the *Data Transfer* window and exit the data logger.
- ❑ Upon returning to the site, select *Navigation* in the data logger Asset Surveyor software main menu. Move the curser to the waypoint listed and press Enter. Move in the direction indicated by the data logger until the waypoint is reached. Waypoints can also be edited on the fly and/or added to the list in the field and transferred back to Pathfinder Office software on the PC for updating and/or exporting back to GIS.

15.3 Vertical Location (Elevation) Surveys

15.3.1 Introduction

The field of surveying that pertains to measuring the relative differences in elevation of two or more points is called "running levels" or "Leveling". The two most commonly used methods are <u>Differential Leveling</u> and <u>Trigonometric Leveling</u>. Differential leveling is the most precise and easiest method because it utilizes "level" measurements with simple addition and subtraction. Trigonometric leveling is slightly less precise and more difficult as it uses vertical angle and distance measurements combined with the principles of trigonometry. Global Positioning System (GPS) equipment can obtain elevation measurements, however this new technology is less accurate than horizontal measurements and is not recommended for vertical locations. This subsection discusses the standard procedures and techniques used to obtain differences in elevation and are described in more detail in basic surveying and field geology textbooks (See References 1, 2, and 3).

Regardless of the method(s) used, elevation surveys should be based on established control points. A network of vertically (and horizontally) located control data points has been established and is continually maintained by the National Oceanic and Atmospheric Administration (NOAA) through its National Ocean Survey (formerly U. S. Coast and Geodetic Survey). The system of vertical control points, or Benchmarks (B.Ms.), are referenced to a surface of fixed and precisely known elevation above mean sea level and is referred to as the datum or datum plane. The datum for vertical control (elevation) is called the National Geodetic Vertical Datum of 1929 (NGVD29), formerly known as the 1929 sea level datum, or the soon to be established North American Vertical Datum of 1988 (NAVD88).

Sources of existing information on benchmark data and their locations may be obtained from local, state, or federal departments or agencies. Typically, engineering or public works departments of counties, cities, or towns may have data on file that is near the particular site being investigated. State or federal agencies that are good sources of useful data include:

- State highway or transportation departments
- State geodetic or land surveying offices
- State natural or water resources bureaus
- State geological surveys
- NOAA/National Ocean Survey
- United States Geological Survey
- Corps of Engineers, Department of the Army
- Soil Conservation Service
- Tennessee Valley Authority
- Bureau of Land Management

When the exact elevations of sampling locations or other physical features are needed, benchmarks of precisely known elevation should be used when leveling. If necessary, a registered land surveyor could be requested to set at least two third-order accuracy vertical control points or benchmarks. The vertical control points should have established elevations referenced to NGVD29 or NAVD88.

If no benchmark is located in the site vicinity, an arbitrary temporary benchmark should be established on a permanent location, e.g., bridge wingwall, foundation, or a nail or spike in a tree or telephone pole. The elevation of the temporary benchmark (and, therefore all other points) could be determined at a later date. As with all field work, the location of benchmarks used should be shown on the site sketch map and all field measurements should be recorded in the field logbook as outlined in Section 3.5.

15.3.2 Equipment Available

The following equipment is available for field use in conducting elevation surveys in support of site investigations:

<u>Differential Leveling</u>

- Sokkia B20 or Lietz B2C, precision automatic level
- tripod
- telescoping level rod

Trigonometric Leveling

- Topcon GTS-2, total station theodolite/electronic distance meter (EDM)
- tripod(s)
- reflector prism(s)
- prism pole
- cloth or steel tape
- compass

15.3.3 Specific Equipment Quality Control Procedures

Field surveying methods using this equipment should be made only by those personnel who have been trained to use them. All field investigators must be trained and checked out in surveying procedures by qualified staff before using this equipment.

Each piece of field equipment (as appropriate) should be numbered, and a log book should be kept containing all maintenance and calibrations made on the equipment. The specific maintenance and calibration procedures found in Section 15.2.3 should be used for all equipment listed above.

15.3.4 Procedures for Differential Leveling

The level, or instrument, is set up by the instrument man at a location not more than 250 feet from the benchmark and at a height above the benchmark and the next point(s). The level is attached to the plate of the tripod by a fastening screw and the bubble in the bullseye level is centered, or brought level by adjusting the three-screw leveling heads accordingly. Once the bullseye bubble is centered, the level is rotated 90 degrees at a time and the horizontal level bubble is checked and brought level using the three-screw leveling heads. The level is ready for use when, after repeated rotations, the bubble in the horizontal level remains exactly in the center or middle of its housing.

The rodman holds the rod as plumb (vertical) as possible on the benchmark so that the instrument man can read where the horizontal cross-hair in the telescope of the level intersects the graduations on the rod. The rodman "rocks" the rod in two planes, when instructed by the instrument man, to obtain a level reading. The rod is white with large red numbers which indicate the foot-marks and smaller black numbers which indicate the tenths of feet and has black graduations the entire length which indicate hundredths of feet. The instrument man sights through the telescope and takes the first rod reading which is called a backsight (denoted BS or + in the field log book). The backsight (+) reading added to the elevation of the benchmark gives the height of the level, or instrument, (denoted H.I. in the field log book). Next the rodman holds the rod on a point (called a turning point and denoted TP) of fixed but unknown elevation such as a nail in the ground, spike in a tree or telephone pole, or the top of a fire hydrant. The instrument man then takes his second rod reading which is called a foresight (denoted FS or - in the field log book). If the foresight (-) reading is subtracted from the H.I., the result is the elevation of the point. That is, the difference between the first reading obtained from the benchmark and the second reading obtained from the point is the difference in elevation between the point and the benchmark. Note that the distance between each sighted reading should not ordinarily exceed 250 feet with turning point backsight and foresight distances deviating no more than 50 feet from one another.

The instrument man then goes ahead of the rodman, sets the level up as stated before and takes a rod reading (backsight) from the previous turning point. The rodman then moves ahead of the instrument man for a new turning point rod reading (foresight) and so forth until the desired final point is located vertically. Once the final point is located, the instrument man breaks the set up of the level (i.e., changes the H.I.) and re-levels the level. The instrument man and rodman then run levels from the last or final point to the first point or benchmark. This is called making a closed circuit or closed level loop.

When practical, leveling should be conducted to form a closed circuit. That is, the level circuit or loop should close back in close agreement to a benchmark by within 0.02 foot of the original reading or third order accuracy whichever is greater. If the level circuit does not close within these limits of accuracy, then the level circuit must be repeated until this accuracy is attained. Third order accuracy is defined by the formula: 0.05 foot × (√number of miles run), which means for a one-mile level circuit, the closure should be within five hundredths of a foot. Figure 15.3.1 is an example of typical field notations for differential leveling.

06/01/01	Project 01-0001 Region 4 Site Name City, State		Landis Surveyor - + Ben Chmark - ø Weather: Clear; 0-5 mph N, hot		
Station/Point	+ or BS	H.I.	- or FS	Elevation	Remarks
B.M 523	6.13	25.69		19.560	Top of brass cap in concrete mon. marked B.M. 523 EL.=19.560'
TP01			6.11	19.58	Set nail in ground
					(Break setup)
TP01	2.24	21.82		19.58	Top of nail
TP02			10.30	11.52	RR spike in telephone pole NW corner Athens ST. and Georgia Ave.
MW01			12.13	9.69	Top of casing at MW01
GS01			14.84	6.98	Ground shot at MW01
WSCS			14.37	7.45	Water surface of cypress swamp
Weir 01			12.54	9.28	Invert of weir 01 south of plant
					(Break setup to run levels back)
TP02	7.89	19.41		11.52	RR spike in telephone pole NW corner Athens St. and Georgia Ave.
TBM 01			8.22	11.19	Set nail in 24" oak for temporary bench mark 01
					Break setup
TBM 01	9.59	20.78		11.19	Top of nail in 24' oak
B.M 523			1.23	19.55	Checked into BM 523 (off -0.01')
					Break setup - put instrument away

Example 1: Figure 15.3.1. Field notation for differential leveling.

15.3.5 Procedures for Trigonometric Leveling

The total station theodolite, or instrument, is usually set up above a benchmark and the elevation of the instrument (H.I.) must be obtained. The theodolite is attached to the plate of the tripod by a fastening screw and the bubble in the bullseye level is centered, or brought level by adjusting the three-screw leveling heads accordingly. Once the bullseye bubble is centered, the theodolite is rotated 90 degrees at a time and the horizontal level bubble is checked and brought level using the three-screw leveling heads. The instrument is ready for use when, after repeated rotations, the bubble in the horizontal level remains exactly in the center or middle of its housing.

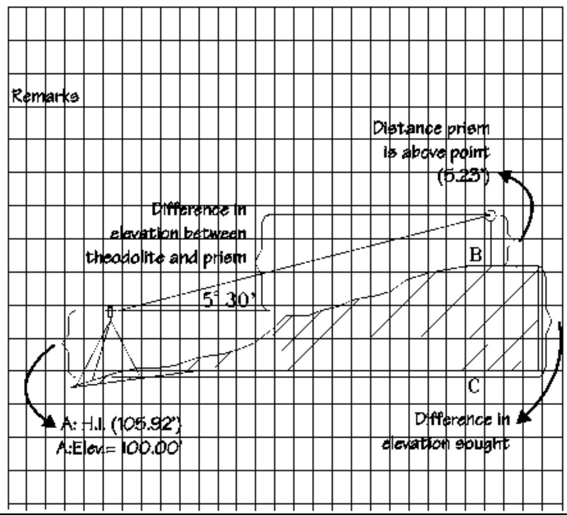
The rodman has either a range pole equipped with a reflector prism (single or triple) or a tripod with the reflector prism. The prism is used to reflect the signal from the electronic distance meter in the total station theodolite. While located over the point(s) whose elevation is desired, the rodman holds the range pole level by means of centering the bullseye bubble, or sets up the tripod by means of centering the bullseye bubble with the three-screw leveling heads. The instrument man sights through the telescope on the theodolite, lines up the horizontal and vertical cross-hairs on the center of the prism, and takes a reading of both the vertical angle (V∢) and the distance to the prism. The difference in elevation between the theodolite and the prism is determined trigonometrically. A compass with a clinometer and a measuring tape could also be used for field measurements or as a map reference.

The following three examples graphically depict the distances that must be considered and accounted for when using the trigonometric leveling method to compute the vertical changes in elevation. The field notation for trigonometric leveling follows each example.

Example 2: The elevation at point A in Figure 15.3.2 is 100.00 ft. The instrument is set up 5.92 ft. above point A which makes the height of the instrument (H.I.) 105.92 ft. Given a slope distance (Ds) shot to the prism (distance AB) of 323.88 ft. and a positive vertical angle ($V\sphericalangle CAB$) of 5°30', the difference in elevation between point C and point B is computed using the trigonometric formula:

$$\text{elevation difference} = \text{distance AB} \times \sin(V\sphericalangle)$$

02/01/96	Project 96E-0001 Region 4 Site Name City, State		Landis Surveyor - + Ben Chmark - ⌀ Weather: Clear; 0-5 mph N	
Station/Point	+ or BS	H.I.	- or FS	Elevation
⌀A	5.92	105.92		100.00'
Distance A-B	323.88'			
Vertical <CAB			5°30'	
⌀B			5.23'	131.73'
	CB = AB x sin <CAB			
	= 323.88' x .0958			
	= 31.04'			
	B = 105.92' + 31.04' - 5.23' = 131.73'			



Example 2: Figure 15.3.2. Trigonometric level notation showing side view when elevation of point desired is above instrument.

The method described in Figure 15.3.2 only accounts for the relative difference in elevation between the theodolite (H.I.) and the center of the prism. The distance that the prism is held above the point in question must be subtracted from the resulting elevation of the prism to obtain the elevation of the point. Substituting in the trigonometric formula:

$$\text{elevation difference} = 323.88 \text{ ft.} \times \sin(5°30') = 31.04 \text{ ft.}$$

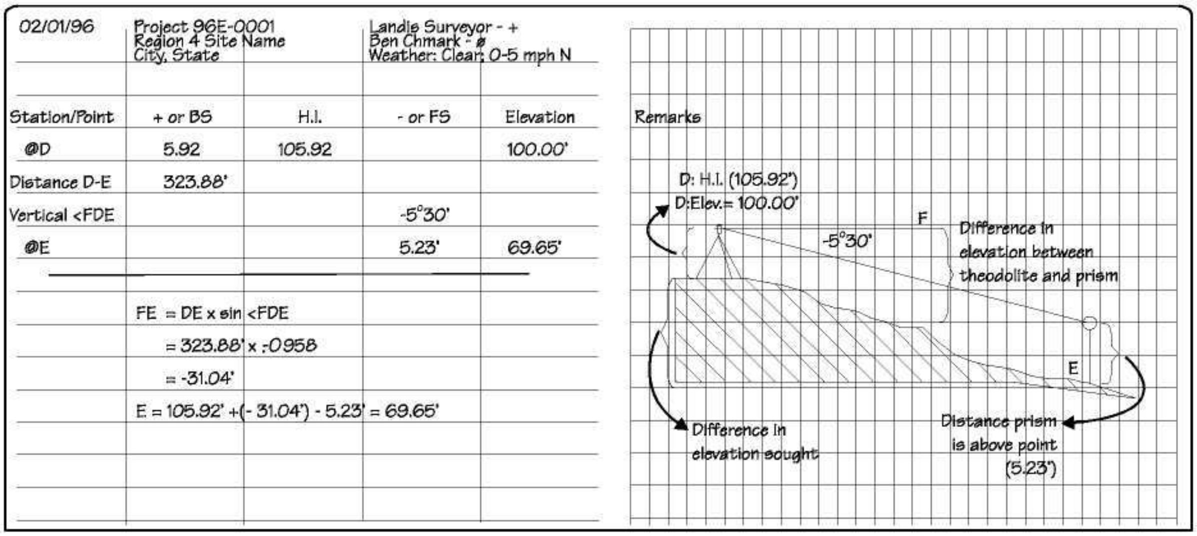
The elevation of point B is: 105.92 ft. + 31.04 ft. - 5.23 ft. = 131.73 ft.

Example 3: The elevation at point D in Figure 15.3.3 is 100.00 ft. The instrument is set up 5.92 ft. above point D which makes the height of the instrument (H.I.) 105.92 ft. Given a slope distance (Ds) shot to the prism (distance DE) of 323.88 ft. and a negative vertical angle (V∢FDE) of -5°30', the difference in elevation between point F and point E is computed by substituting in the trigonometric formula:

$$\text{elevation difference} = 323.88 \text{ ft.} \times \sin(-5°30') = -31.04 \text{ ft.}$$

The distance that the prism is held above the point in question must be subtracted from the resulting elevation of the prism to obtain the elevation of the point.

The elevation of point E is: 105.92 ft. + (-31.04 ft.) - 5.23 ft. = 69.65 ft.



02/01/96	Project 96E-0001 Region 4 Site Name City, State		Landis Surveyor - + Ben Chmark - ø Weather: Clear, 0-5 mph N	
Station/Point	+ or BS	H.I.	- or FS	Elevation
@D	5.92	105.92		100.00'
Distance D-E	323.88'			
Vertical <FDE			-5°30'	
@E			5.23'	69.65'
	FE = DE x sin <FDE			
	= 323.88' x -.0958			
	= -31.04'			
	E = 105.92' +(- 31.04') - 5.23' = 69.65'			

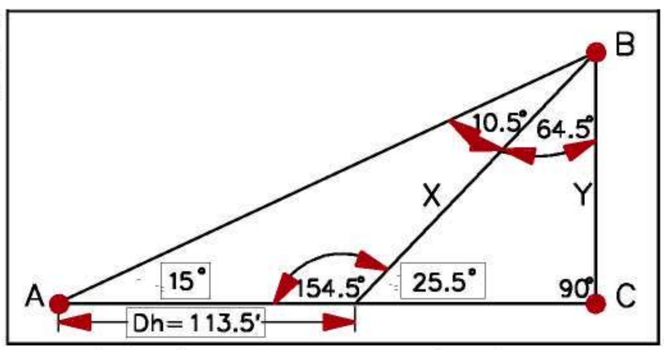
Example 3: Figure 15.3.3. Trigonometric level notation showing side view when elevation of point desired is below instrument.

Example 4: When the measurement of the slope distance is not possible, differences in elevation can be determined using the law of sines from trigonometry:

$$\frac{\sin\alpha}{a} = \frac{\sin\beta}{b} = \frac{\sin\gamma}{c}$$

or

$$\frac{a}{\sin\alpha} = \frac{b}{\sin\beta} = \frac{c}{\sin\gamma}$$



Example 4: Figure 15.3.4. Spot elevation differences using law of sines.

Spot elevation differences can be determined by taking only three measurements (shown enclosed in the boxes of Figure 15.3.4). The measurements can be obtained with the total station theodolite or by using a compass (equipped with a clinometer) and a measuring tape. In Figure 15.3.4 the vertical angle (V∢) is measured at two locations (A and midway between A and C) and the horizontal distance (Dh) between those two measurements is also measured. Since the sum of the interior angles of each triangle should equal 180°, all the other interior angles are calculated. Substituting the measurements into the law of sines and solving for x and y shown in Figure 15.3.4:

$$\frac{x}{\sin 15°} = \frac{113.5'}{\sin 10.5°} \qquad \frac{y}{\sin 25.5°} = \frac{161.36'}{\sin 90°}$$

$$x = \frac{(\sin 15°)\ 113.5'}{\sin 10.5°} \qquad y = \frac{(\sin 25.5°)\ 161.36'}{1}$$

$$x = 161.36' \qquad y = 69.4'$$

Note that this method above only accounts for the relative difference in elevation between point A and the point in question, point B. If an instrument, such as a compass or theodolite, is used at point A, the H.I. at point A must be added to the resulting elevation of the point in question. The field notation would include the figure drawing, all field measurements, and all of the calculations.

15.4 Hydrological Studies

15.4.1 Scope and Applicability

Hydrological studies are an important component of virtually all Branch field studies and include activities such as time-of-travel studies, current/circulation studies, dye dilution surveys, flow measurement and stage/discharge relationship development. Time-of travel surveys are frequently required as part of water quality model calibration surveys or as a component of other activities such as reaeration measurements. Dye dilution studies are extremely useful for evaluating the mixing of effluents with receiving waters. Activities such as water quality enforcement studies, NPDES permit compliance monitoring, water quality survey monitoring, reconnaissance surveys, and research rely on accurate flow measurement. For example, NPDES permit limits often limit the mass loading of a particular pollutant that may be discharged. Stage measurement and the determination of stage-discharge relationships are also important hydrological data collected by the Branch. For example, stage-discharge studies are extremely useful for determining flow in conjunction with TMDL storm event sampling efforts. As much attention and care should be given to hydrological measurements in the design of a sampling program as to the collection of samples and subsequent laboratory analysis.

15.4.2 Methods

15.4.2.1 Surface Water Stage/Tape Down

Water level recorders provide a time series record of water levels. When necessary, these instruments should be referenced to National Geodetic Vertical Datum (NGVD). All water level tracings should be noted with beginning and ending date and time, site location, stage scale, and time scale and initialed by the field investigators. Standard USGS staff gages should be employed at each water level recorder site to provide a reference and check on the recorder trace. Water stage should be recorded to the nearest 0.01 foot where possible.

Tape downs provide instantaneous water stage as referenced to a known elevation. An engineering tape is fashioned with a plumb bob to measure from a bridge deck or other reference point to the water surface. The plumb bob provides weight for the tape as well as providing a discernible contact with the water surface. All measurements should be to the nearest 0.01 foot accompanied by a date, time, and station location. The exact reference or point from which a tape down is measured should be permanently marked on the reference (wing wall or bridge rail by etching a reference with a chisel, etc.) and a complete description of the reference should be made in the field records.

Both of these procedures (water stage and tape downs) are predicated upon accurate references to established measuring points. As mentioned above, the NGVD is an established datum that provides correlation of water surface recordings to engineering structures (bridge, wing walls, sea wall caps, clarifier cat walks, etc.). When recording water level dynamics in relation to a particular flow device, the datum is established in relation to the flow device reference point. The flow through rectangular and V-notch weirs, for instance, are proportional to the water level referenced to the weir crest or, in the case of partially filled pipes, the flow rate is proportional to the depth of flow. Therefore, when employing a water level recorder or tape down on primary flow devices, the reference or datum is the weir crest or in the case of pipes, the invert (see Section 18, Wastewater Flow Measurement).

15.4.2.2 Time-of-Travel

Three principal methods are used to determine time-of-water-travel time in streams, i.e., surface floats, measurements of cross sectional velocity, and tracers such as dye.

A very rough method for preliminary estimates of time-of-water-travel consists of dropping sticks or other buoyant objects in the stream reach under observation, and noting the time required for them to float an estimated 10 feet or some other convenient distance. The velocity estimates are too inaccurate for use in interpretation of data or final reporting, but can be useful in preliminary planning of studies and in subsequent more precise measurements of time-of-water-travel.

Stream velocities at gaging stations, measured by the U. S. Geological Survey in developing rating curves, may be applied to the entire reach under observation to estimate time-of-water travel. This is somewhat more refined than the floating objects estimates, but can still be far from accurate. There rarely are more than one or two gaging stations in most stream reaches being studied. Stream channels generally are restricted at gaging stations and velocities there are generally higher than average velocities throughout the reach. Cross sectional velocities can also be determined at locations designated for a particular study.

Tracer dyes provide a direct and highly accurate method of determining time-of-travel. This is the preferred method if resources are available.

Floats

Surface floats may be followed downstream and timed for known distances to determine time-of-water-travel. This requires the use of considerable judgment, for floats tend to travel into quiet or eddy areas, or to become stuck on tree limbs, the stream bank, or other obstacles. The floats must frequently be retrieved and returned to the stream current. The principal judgment factors are how long the floats should be left in quiet areas before retrieval and where they should be placed in the current.

Surface water velocity is greater than the average for the entire stream, and a correction factor must be applied to the surface velocity. An average velocity of about 85 percent of that of the surface velocity is a reasonable rule-of-thumb value.

Cross Section Measurements

The measurement of cross sectional velocities at frequent longitudinal intervals and the calculation of average velocity in the stream constitutes a time consuming method of obtaining time-of-water-travel.

The longitudinal intervals at which cross sections should be measured vary with the characteristics of the stream channel. One cross section per mile may be adequate for streams with reasonably uniform channels. Cross sections at every tenth of a mile may be desirable for streams with irregular channels.

Tracers

The most accurate method of measuring time-of-travel involves following and measuring a tracer. Some conservative constituents such as salt, or radioisotopes may serve as tracers; however, Rhodamine WT dye is the most common tracer used. Rhodamine WT is water soluble and can be detected at concentrations as low as 0.01 ppb by a fluorometer.

Prior to injection into the stream, the concentrated dye is often diluted with stream water. This insures immediate maximum dispersion. Addition of concentrated dye without dilution may result in incomplete dispersion, particularly in shallow streams. Calibration curves should be developed for each study with particular emphasis on accounting for natural background fluorescence.

The dye should be distributed across the stream at the upstream point, as nearly instantaneously as possible. The ideal distribution produces a narrow band of tracer in a uniform concentration across the stream. The band of tracer mixes with water ahead of and behind it by diffusion, or longitudinal mixing, as it moves downstream to produce an increasingly wider band. The peak concentration remains near, but somewhat downstream of, the center line of the band and decreases as longitudinal mixing proceeds. The times-of-water-travel to downstream points are the differences between the time the dye was added to the stream and the times the centroid of the dye mass arrives at downstream points. The length of the dye cloud and the peak concentrations produces a measure of instream dispersion.

If Rhodamine WT dye is used as the tracer, peak concentrations from 1.0 to 50 ppb allow satisfactory definition of the dye concentration curve.

Most methods of calculating the dosage of dye needed at the upstream point involve estimates of one or more stream characteristics, such as flow, velocity, length of reach, volume in the reach, cross-sectional area, average depth, or the roughness coefficient "n" of Manning's formula. The USGS has produced excellent publications regarding time-of-travel techniques, i.e., "Measurement of Time-of-Travel and Dispersion by Dye Tracing" (12) and "Fluorometric Procedures for Dye Tracing" (10).

The stream should be sampled frequently as the dye arrives at the downstream point to define the tracer concentration versus time curve with special emphasis on the peak. The frequency may be varied from continuously to every 60 minutes or more, depending on the duration of the dye cloud at the sampling point. The dye may be missed altogether by overestimating the time required for it to travel downstream. Much time may be wasted, on the other hand, waiting for it to arrive if the time-of-travel is underestimated. All information that will contribute to the best possible preliminary estimate of the time required should be used.

There are two primary methods by which the stream water can be sampled and analyzed for dye. A submersible pump can be used to pump the dye continuously through a fluorometer, or the stream samples can be grabbed (either by hand or by automatic sampler) at specified frequencies and then placed into the fluorometer individually. Readings directly from the fluorometer scale or conversion to dye concentration can be manually plotted against time.

A version of the grab sampling technique would be to use an automatic water sampler which discharges into separate bottles. The samples collected at preset intervals are analyzed and the concentrations are plotted against time.

Ideally, dye samples should continue to be analyzed until the stream background concentration following the peak is measured. With a time versus concentration plot from background level to peak to background level, the centroid, and thus actual travel time, can be determined. Where it is infeasible to continue monitoring to the stream background concentration, the trailing edge of the dye cloud should at least be monitored until the in stream tracer concentration is no more than 2 to 5 % of the peak concentration.

Prior to conducting tracer studies in freshwater systems, water supplies should be inventoried to insure that the dye tracer concentrations will not impart color to downstream public or private water supplies. Rhodamine WT concentrations in the dye cloud should be maintained below 10 ppb at water supply intakes. Commercially available Rhodamin WT is a 20% solution.

15.4.2.3 Dilution

A great deal of the previous section (time-of-travel studies) applies to this section and USGS publications provide references to appropriate techniques, in particular "Measurement of Discharge by Using Tracers". (11)

Dilution studies using tracer dyes evolved from "mass conservation" principles, i.e., a known mass of tracer is introduced at an upstream point, and after mixing with the water to be traced, this mass should be accountable at downstream locations. Rhodamine WT provides an adequate tracer for most investigations. This dye is slightly photoreactive. Decay rates (e^{kt} where k=0.034/day for exposure to full sunlight) are reported in the literature. Due to limited light penetration, actual rates are normally insignificant or can be established through on-site bottle tests. Other tracers either introduced into an upstream point or in some instances occurring at the upstream point are often used. The high degree of accuracy and detection ability of fluorometers plus the solubility properties of tracer dyes make them the technique of choice.

In dilution studies, the tracer dye is precisely metered into the waters to be traced and then monitored after mixing via a fluorometer at downstream stations. This series of events requires highly controlled metering rates and very accurate fluorometric analyses. State-of-the-art fluorometers make the dilution study methods valuable assessment tools.

The principal of superposition as developed by Kilpatrick et al. (13) of the USGS is a reliable method to determine dilution levels of wastewaters in receiving estuaries. A tracer dye is metered into the wastewater stream during a tidal cycle. Successive slack tide measurements of dye concentrations in the estuary at selective distances from the outfall produce a series of concentration curves. By superposition, the accumulative concentration at each station provides a determination of the ultimate concentrations or steady-state concentration of a continuous discharge. By simple proportioning, with due regard to any tracer photo decay, the dilution levels of the discharge can be produced for selective points in the estuary.

Calculation Procedure:

$$C_w = \frac{(C_t)(e^{kt})(Vw)}{Vt}$$

Where:

C_w = Ultimate concentration of wastewater at point of interest

C_t = Ultimate concentration of tracer (by superposition) at point of interest

t = Tidal days to ultimate concentration

e^{kt} = Photo decay of tracer

V_w = Wastewater discharge per tidal day

V_t = Volume dye released in tidal day

Investigations of industrial and municipal facilities for NPDES permit compliance require measurements of discharge rates. Often encountered during these investigations are flow measuring devices such as orifices and magnetic meters which are inaccessible for measurements of flow by standard equations relating to hydraulic head and structure size. The following provides a direct technique for measurement of flow through these devices using dye tracers.

Calculation:

The discharge rate through any structure can be defined by the following mass balance equation:

MASS BALANCE EQUATION

$$(C_1)(q_1) = (C_2)(Q_2 + q_1)$$

$$Q_2 = \frac{(C_1)(q_1) - (C_2)(q_1)}{C_2}$$

Where:

Q_2 = pipe flow rate

C_2 = tracer concentration after mixing

q_1 = tracer injection rate

C_1 = tracer injection concentration

Assuming a constant discharge rate and complete mixing of the tracer in the waste stream, the task is (1) to inject into the waste stream a tracer at a constant rate and constant concentration and (2) to measure the concentration of the tracer after mixing with the waste stream.

It is suggested that at least three injection rates and resulting mixed tracer concentration measurements be used to calculate the discharge rate.

EPA's Technical Support Document also provides guidance for conducting a "quick saltwater dilution assessment" using a dye tracer (15).

15.4.3 Current Measurement

Current measurements may be made by either an axial-flow, ducted impeller recording current meter (Endeco 174) or an Acoustic Doppler Current Profiler (ADCP). Both meter types may be programmed via appropriate connection to a PC prior to deployment, deployed in an unattended mode, and interrogated for data download by PC following data collection. Likewise, the meters may be used for real-time data collection in profiling applications. For unattended applications, deployment in and out times/dates should be recorded in the field record. The field record should also include the location and depth(s) of the deployment and serial number or other appropriate identifier of the meter(s) used in the deployment.

For unattended applications, the impeller-type meters are deployed on a weighted tether line with a subsurface float (to keep the tether line taut) and a surface float (for locating the meter). Multiple meters can be deployed at any depth(s) on the tether. For a non-stratified system, one meter will generally be deployed at mid-depth. For a stratified system, a meter will generally be deployed at the mid-depth of each strata. Anticipated deployment depths for a given application should be provided in the Quality Assurance Project Plan.

Care should be taken during deployment of the impeller-type meters to prevent tangling of the tether line around the meter and/or floats. The meter should also be checked for level deployment in the water. Lead weights attached at the nose and tail ends of the meter should be added or removed as needed to ensure the meter is axially deployed (horizontal) in the water column. Meters should be deployed in a way that minimizes potential equipment damage or interference from ship traffic or other obstructions.

ADCP meters may be mounted in a variety of ways; however, for unattended current measurements, these meters will typically be deployed in upward facing configuration with the meter mounted to a weighted platform specifically designed to minimize potential impacts from drag lines or nets. The meter may also be boat mounted in a downward facing configuration for real-time data collection and profiling.

15.4.4 Equipment

The following equipment is available for surface water stage/tape down measurements:

- Model F Stevens Stage Recorder(s) (mechanical, horizontal drum system);
- Model A-71 Stevens Stage Recorder(s) (mechanical drum system);
- Stevens Model GS-93 Endcoders and Loggers;
- Stevens AxSys System (pressure transducer);
- Model 1870, 2870, 3210, 3230, and 4210 ISCO flow meter(s) and Recorder(s) (pressure transducer, bubbler, and ultrasonic reflection systems)
- USGS staff gage(s); and
- Weighted steel tape-down systems

The following equipment is available for time-of-travel and dilution studies:

- Turner 10-AU and Turner 10-005 fluorometers,
- Rhodamine WT dye tracer and standards,
- ISCO automatic samplers,
- Peristaltic, submersible, and metering pumps,
- recorders,
- flow meters, and
- floats

The following equipment is available for flow/current measurement:

- cup-type current meters (pygmy/price),
- impeller-type current meters (Endeco),
- sounding (depth) equipment, and
- ADCP

15.4.5 General Quality Assurance Procedures

No field investigator shall make flow measurements until they have had at least six months of actual field experience and have performed these measurements under the supervision of a senior field investigator.

Wastewater flow shall be expressed in million gallons per day (MGD) or the metric equivalent (m^3/day). Stream flow shall be expressed in cubic feet per second (cfs) or the metric equivalent (m^3/sec). Current velocities shall be expressed in feet per second (fps) or the metric equivalent (m/sec). Time records associated with hydrological studies shall be (1) kept in local time, (2) recorded in 24 hour military format, and (3) recorded to at least the nearest five minutes.

All field equipment shall be operated, calibrated, and maintained according to manufacturer's specifications. All equipment shall be visually inspected prior to deployment to ensure proper operation.

15.4.6 Data/Records Management

All hydrological measurements shall be thoroughly documented in field records. All measurements shall be traceable to the personnel making the measurements and the equipment utilized.

15.5 Ground Water Level Measurements

15.5.1 General

The measurement of the ground water level in a well is frequently conducted in conjunction with ground water sampling to determine the "free" water surface. This potentiometric surface measurement can be used to establish ground water flow direction and gradients. Total well depth and ground water level measurements are needed to determine the volume of water in the well casing prior to purging the well for sampling purposes.

All ground water level and total depth measurements should be made relative to an established reference point on the well casing and should be documented in the field records. To be useful for establishing ground water gradient, the reference point should be tied in with the NGVD (National Geodetic Vertical Datum) or a local datum. For an isolated group of wells, an arbitrary datum common to all wells in that group may be used if necessary.

15.5.2 Specific Ground Water Level Measuring Techniques

Measuring the depth to the free ground water surface can be accomplished by the following methods (9). Method accuracies are noted for each of the specific methods described below.

- Electronic Water Level Indicators -- This instrument consists of a spool of dual conductor wire, a probe attached to the end, and an indicator. When the probe comes in contact with the water, the circuit is closed and a meter light and/or buzzer attached to the spool will signal the contact. Penlight or 9-volt batteries are normally used as a power source. Measurements should be made and recorded to the nearest 0.01 foot.

- Weighted Tape -- This method is similar to the "bell sounder" method, except that any suitable weight, not necessarily one designed to create an audible pop, can be used to suspend the tape. The weight should, ideally, be made of a relatively inert material and should be easily cleaned. Measurements should be made and recorded to the nearest 0.1 foot.

- Chalked Tape -- Chalk rubbed on a weighted steel tape will discolor or be removed when in contact with water. Distance to the water surface can be obtained by subtracting the wet chalked length from the total measured length. The tape should be withdrawn quickly from the well because water has a tendency to rise up the chalk due to capillary action. Measurements should be made and recorded to the nearest 0.01 foot. This method is not recommended if samples are to be collected for analyses of organic or inorganic contaminants.

- Other Methods -- There are other types of water level indicators and recorders available on the market such as the sliding float method, air line pressure method, and electrical and automatic recording methods. These methods are primarily used for closed systems or permanent monitoring wells. Acoustic water level indicators are also available which measure water levels based on the measured return of an emitted acoustical impulse. Accuracies for these methods vary and should be evaluated before selection. Any method not capable of providing measurements to within 0.1 foot should not be used.

15.5.3 Total Well Depth Measurement Techniques

The bell sounder, weighted tape, or electronic water level indicators can be used to determine the total well depth. This is accomplished by lowering the tape or cable until the weighted end is felt resting on the bottom of the well. Because of tape buoyancy and weight effects encountered in deep wells with long water columns, it may be difficult to determine when the tape end is touching the bottom of the well. Care must be taken in these situations to ensure accurate measurements. All total well depth measurements must be made and recorded to the nearest 0.1 foot.

15.5.4 Equipment Available

The following equipment is available for ground water level and total well depth measurements:

- weighted steel measuring tapes

- electronic water level indicators.

15.5.5 Specific Quality Control Procedures

Devices used to measure ground water levels should be calibrated against the Invar steel surveyor's chain. These devices should be calibrated to 0.01 foot per 10 feet length. Before each use, these devices should be prepared according to the manufacturer's instructions (if appropriate) and checked for obvious damage. These devices should be decontaminated according to the procedures specified in Appendix B prior to use at the next well. All calibration and maintenance data should be recorded in a log book.

15.6 Surface Geophysical Studies

15.6.1 General (17)(18)

The science of geophysics can be defined as the study of the earth's physical properties. Surface geophysical studies are investigations which use indirect measurement instrumentation and techniques to evaluate these properties from points on or above the earths surface. Many of the surface geophysical methods used today for hazardous waste site investigations found their start almost exclusively in geophysical prospecting for oil, gas and minerals. Geophysical methods typically obtain and provide data measurements in a one or two dimensional pattern. It is sometimes possible, using data output from some of the two dimensional patterns, to generate three dimensional interpretations of the data, clearly showing the locations and relative intensities of the anomalies. These techniques provide a much more rapid, safe and economical way to investigate the subsurface at hazardous waste sites, as compared to direct sampling techniques such as monitoring well installation and subsurface soil sampling. Measurements obtained from available geophysical instrumentation can be used to locate buried materials or areas of disturbance, to characterize the geologic setting, or to locate a contaminant plume.

When planning a hazardous waste site investigation, strong consideration should be given to incorporating the use of geophysical methods in the investigation. Geophysical equipment can be used to screen a site for the presence of metallic or conductive material in a short period of time with fairly accurate results. Surface geophysical methods are also valuable aids in determining sampling locations in areas where drilling or direct sampling would be too time consuming and costly, or would create a dangerous situation. Often times, it is these geophysical data measurements that can assist in guiding the latter phases of an investigation.

When selecting the geophysical method(s) best suited for a study, certain site factors should be considered. They include: the type of soils, the depth to ground water, general ground surface conditions (wet, dry, frozen), large surface or subsurface ore bodies, depth to bedrock, type of topography, large surface metallic objects (building, tanks, pipes, etc.), power lines and underground cables, buried drums, and/or contaminant plumes, etc. Once site conditions are known and evaluated, then the instrument(s) have to be selected that will be most applicable to the specific site.

Geophysical techniques available for site investigations by Branch personnel can be placed into two categories, electrical and magnetic. The electrical methods include metal detection, electromagnetics (EM), and VLF (very low frequency). The magnetic method is referred to as magnetometery. These will be described in further detail later in this section. Other geophysical techniques and methods, such as ground penetrating radar (GPR), resistivity, seismic refraction and reflection, gravity, temperature, and radioactive methods are available from EPA contractors. Depending on site conditions and study objectives, one or more of these methods might be used in a hazardous waste site investigation.

Several practical tips, listed below, should be considered prior to using geophysical equipment during an investigation.

- Becoming familiar with the instrument and it's principle of operation before attempting a geophysical survey is extremely important.

- Normally, at least a two-person team is adequate for a small-scale geophysical study. However, some surveys may require more personnel due to the size of the site.

- Prior their use during a study, all geophysical equipment shall be inspected to ensure it is in good working condition and/or calibrated according to the manufacturer's procedures included with each instrument. Battery voltage should be monitored closely, especially in cold weather.

- Ancillary information shall be recorded in a field book as to the date and times calibrated, team members, and a complete chronological description of what transpired during the study.

- As a general rule, the locations of any geophysical anomalies detected during a surface geophysical study shall be documented using standard surveying techniques. At a minimum, a key coordinate or coordinates in the grid should be spatially identified (azimuth and distance), relative to obvious and permanent landmarks, for future reference. A typical coordinate grid where the station and line numbers are all defined as positive and which extend from the grid origin in the north (Y) and east (X) directions, eliminates confusion while recording and processing data.

- Review data, as much as possible, while it is being recorded for erroneous readings. Reoccupy station locations to verify data if necessary.

15.6.2 Specific Surface Geophysical Methods

The following is a brief description of the electromagnetic and magnetic geophysical instruments used by Branch personnel, their capabilities, and some of their limitations.

Electrical Methods

Metal Detection

Metal detectors are used to detect changes in electrical conductivity caused by the presence of metallic materials, both ferrous and non-ferrous. Metal detectors: (1) are generally limited to shallow depths (1 to 3 meters); (2) can detect large metallic objects such as buried ferrous material and/or metallic laden wastes at depths of 3 to 6 meters; (3) are insensitive to soil moisture and small metallic objects; and, (4) are light weight and economical.

Several different metal detectors are available for use. These are described below.

- Standard "Treasure Seeker" Metal Detector - This is the typical hand held unit with a disk that is swept across the ground surface. It is useful for locating items of small mass that are located at or just below the ground surface or items of moderate or large mass that are located relatively close to the ground surface.

- Pipe and Cable Locator - These instruments are much more sensitive than the treasure seeker-type instruments. They generally are capable of detecting decreasing smaller mass objects at increasingly greater depths, as compared to the treasure seekers. Three instruments are available under this broad category, the TRACER Pipe Seeker 5 Metallic Pipe and Line Locator, the Fisher M-SCOPE TW-6 Pipe and Cable Locator and the Schonstedt MAC-51B Heliflux Magnetic and Cable Locator. Each of the three can be used in simple survey mode or can be used in the conductive mode, where low current electrical signals are induced into cables and traced from the surface.

The basic operating principle of the typical pipe or cable locator is as follows. A small AC voltage, at an audio frequency, is sent through the transmitter coil causing a current to flow. The transmitter on the metal detector generates an alternating magnetic field around the transmitter coil. The primary magnetic field is canceled or nulled at the receiver coil by orienting the planes of the transmitter and receiver coil perpendicular to one another. Eddy currents, induced from the primary field, in a metallic object within the range of the instrument, produces a secondary field. This secondary field interacts with the primary field causing the canceled or nulled condition to become upset. This results in an output in the form of a meter deflection and/or audio signal.

<u>Electromagnetic Induction</u> (EM) (17)(18)(19)(20)(21)(22)(23)

EM induction instruments measure true soil conductivity in uniform, homogeneous subsurface conditions and can also measure apparent soil conductivity in layered soils or other geologic material. The EM data measurements have also been called ground or terrain conductivities or reciprocal resistivities. EM units are very effective for rapid site reconnaissance and detection of buried drums, pipes, metallic type conductors or trenches were the conductivity of the disturbed soil would differ from the native soil. EM induction instruments are not limited by frozen ground, or wet or dry soils.

Two EM instruments available for use by Branch personnel are the EM31-D and the EM34-3. The EM31-D is a fixed coil separation instrument with an intercoil separation of 3.66 meters and is capable of providing both terrain conductivity and metal detection data. The effective depth of investigation with the EM31-D is approximately 5 to 5.5 meters (15 to 18 feet), depending on location relative to the ground surface. The EM31-D can be connected to a data logger for logging EM data during surveys. This data can later be down-loaded into a PC for post-processing. The EM34-3 utilizes variable coil spacing, however, and is capable of providing a much greater depth of investigation, though only for terrain conductivity. With intercoil spacings of 10, 20 and 40 meters, depths of investigation may reach 15, 30 or 60 meters (45, 90 or 120 feet), respectively. The EM34-3 does not allow electronic data logging. Both instruments may also be operated with the coil dipoles in different orientations, effectively providing for a different investigation depth at each measurement point.

The principle of operation of EM instruments is as follows:

> A small AC voltage, at an audio frequency, is sent through the transmitter coil causing a current to flow. The transmitter coil on the EM-31D generates an alternating magnetic field that directs induced electrical current loops into the ground, which produce primary and secondary magnetic fields. These magnetic fields are then sensed or detected by the receiver coil, and then amplified and stored on a data logger. The ratio of the primary and secondary fields are incorporated into the design of the EM instruments such that the meter readings are true or apparent ground (soil) conductivities.

<u>Very Low Frequency</u> (VLF) (17)(24)

VLF geophysical instruments utilize the long distance, high power, very low frequency radio transmissions that the military has developed for submarine communications. At least 15 VLF transmitters are at various locations around the world and continuously operate at 15-30 kHz. VLF transmitters can be used at distances up to 10,000 kilometers (6,214 miles) from a powerful transmitter.

The ABEM Wadi is the VLF instrument available for use by Branch personnel. It is a hand-held instrument, complete with a belt-mounted battery supply and radio signal receiver. Information necessary to define a profile line or survey grid is input into the hand-held unit. After a transmitter is selected, the operator occupies a measurement point and presses the measurement keypad. At any time during the survey, the instrument will interpret any anomalies that are identified. The complete data may also be post-processed to create anomalie maps.

Primary electromagnetic radio waves are generated by the VLF transmitters. The Wadi measures the vertical and horizontal in-phase and out-of-phase components of the secondary electromagnetic field, which is induced in the more conductive geological structures (water-filled faults, fractures, etc.). The measurements are displayed as the vertical in-phase field expressed as percentage of the horizontal field and recalculated as current density.

Magnetic Method - Magnetometry (17)(18)(25)(26)

The science of magnetism is called magnetics. The earth's magnetic field has both direction and a magnitude or intensity. Generally, magnetometers have been designed to detect and accurately measure changes in the earth's magnetic field. The magnetic field of the earth resembles the characteristics of a bar magnet. The magnetic south pole is located near the geographic north pole. Magnetic field lines always move from the north pole to the south pole outside of a magnet. This explains why the charged pole of a compass needle is attracted to the north (geographic) or magnetic south pole. The units of the earth's magnetic field intensity are nanoTesla (nT), which is numerically equal to gamma, the common unit seen in publications and maps.

Branch personnel have two different magnetometers available for conducting magnetic surveys. These are the EG&G Geometrics Unimag II Portable Proton Magnetometer Model G-846 and the EG&G Geometrics Model G-856 Proton Precession Magnetometer. The G-856 is the newer unit and, compared to the G-846, is capable of providing greater resolution of magnetic field data (0.1 nT vs. 1.0 nT for the G-846) and is capable of logging 1,000 stations of data for subsequent retrieval and post-processing.

A magnetometer's primary design function is detection of magnetic objects such as buried ferrous materials or large bodies of ore which alter the earth's magnetic field. Individual drums can be detected at depths up to 6 meters whereas large masses of drums may be detected at depths of 6 to 20 meters. Magnetometers are susceptible to noise from many different sources and therefore should not be calibrated or used in or around buildings, near powerlines, or directly on the ground. The total magnetic field measurements from a proton precession magnetometer are based upon an atomic constant, and do not depend on temperature, humidity, and sensor orientation.

The proton magnetometer operates by applying a voltage to a coil around a vessel containing a hydrocarbon fluid such as decane. The resultant magnetic field orients the protons in the fluid. The protons reorient or precess and line up with the earth's magnetic field when the voltage is removed. Through nuclear precession, a signal is generated and the precession frequency of this signal is proportional to the strength of the total magnetic field. The magnetometer amplifies this precession frequency signal and electronically translates the signal into nanoTeslas or Gammas. The presence of ferrous metals creates variations in the local strength of the magnetic field, permitting their detection with a magnetometer.

15.6.3 Instrument Operations

All personnel trained in the use of any of the above described surface geophysical instrumentation will retain in their possession, copies of operations manuals for each of the instruments. In addition, a copy of each of the manuals will be maintained by a designated person within the Hazardous Waste Section. All instruments will be used consistent with the instructions contained within these manuals, with respect to preliminary instrument operational and sensitivity checks, as well as actual operation during data collection.

15.6.4 Specific Instrument Quality Control Procedures

All geophysical instruments used by Branch personnel or EPA contractors shall be calibrated in accordance with the manufacturers' specified calibration procedures, and shall only be calibrated by personnel that have been trained to do so. The calibration shall be checked periodically to insure accurate readings, especially on re-entering the study area after having left for a period of time. All calibration procedures and pertinent information shall be documented in the field logbook as outlined in Section 3.5.

Personnel using the geophysical equipment shall be trained in the use and maintenance of such equipment, and shall be able to interpret and present the gathered data in an easily understood manner in charts, graphs, maps, and formal reports. It is the responsibility of each project leader to insure that the personnel designated to use the geophysical equipment are qualified in the calibration and use of the equipment, and able to gather and interpret the data.

Training on the calibration and use of geophysical equipment that is currently available will be conducted by qualified Branch personnel and will be given to other Branch personnel during in-house training sessions scheduled throughout the year.

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SECTION 16
FIELD MEASURABLE PHYSICAL/CHEMICAL CHARACTERISTICS

PERFORMANCE OBJECTIVES:

To measure physical/chemical characteristics of a sample that are representative of field conditions as they exist at the time of sample collection by selecting the appropriate meter/instrument(s) and by properly calibrating or verifying each instrument

16.1 Introduction

Temperature, specific conductance (conductivity), hydrogen-ion concentration (pH), turbidity, dissolved oxygen (DO), chlorine, salinity, flash point, and the halogen test are discussed in this section. The order in which the measurements are made may be important in some field investigations. The parameters will be discussed in the most applicable order. References for each parameter can be found at the end of the section.

Numerous meters/instruments are commercially available. Some meters are capable of multiple measurements which may include: pH, temperature, conductivity, DO, salinity, and turbidity; therefore, individual meters discussed here are not necessarily the only ones available. However, the setup and use of all instruments should follow a basic format to ensure consistency.

Quality Control

All equipment should be maintained and operated in accordance with the manufacturer's instructions. Regardless of the meter used, it should be properly calibrated or verified prior to use. All field meters with thermistors are verified against a National Institute of Standards and Technology (NIST) traceable thermometer, the Hanna Instruments CheckTemp 1 or equivalent, at least semi-annually. This includes, but is not limited to, the pH, conductivity, and DO meters. These verification checks are documented in a logbook and maintained at the Federal Equipment Center (FEC). Labels are placed on the field instruments to indicate when the next verification check is required. Additionally, the CheckTemp 1 is NIST Certified at least annually and documented.

The thermistors for all pH, conductivity, and DO meters should be verified in the field with one of the NIST traceable Fisher brand stem-type digital thermometers. All data for the field verifications should be documented in the inspector's logbooks.

The turbidimeter is calibrated with Formazin Primary Standards semi-annually and a record of the calibration is maintained on file at the FEC. The Gelex secondary standards will be standardized against the Formazin Primary Standards by the FEC. The turbidimeter should be verified with the Gelex secondary standards before each use. These verifications should be documented in the inspector's logbook.

Standard Methods requires that the conductivity meter's electrode cell be verified by comparing against a laboratory meter with a platinum-electrode type conductivity cell. The FEC will perform and document this quality control check at least annually, especially if the meter is used for NPDES monitoring activities. A label will be placed on the field instruments to indicate when the next verification check is required.

16.2 Temperature

Normally, temperature measurements may be made with any good alcohol-filled thermometer or a NIST traceable digital thermometer. As a minimum, the thermometer should be capable of reading or have a scale marked in 0.1 °C. For field operations with glass thermometers, a thermometer having a metal case to prevent breakage should be used.

Calibration:

Calibrate any temperature measurement device by checking annually against a National Institute of Standards and Technology (NIST) certified thermometer. Clearly indicate whatever correction must be applied to the thermometer.

Note: Thermistors should be checked against a NIST traceable thermometer prior to use and should agree within ± 4.0 °C. Corrections must be applied for measurements up to ± 4.0 °C, but the instrumentation must be repaired or replaced beyond that range.

Inspection:

All thermometers should be inspected for leaks, cracks, and/or function prior to use.

Procedures: (Make measurements in-situ when possible)

1. Clean the probe end with de-ionized water and immerse into sample.
2. Swirl the thermometer in the sample for mixing and equilibration.
3. Allow the thermometer to equilibrate with the sample for at least one minute.
4. Suspend the thermometer away from the sides and bottom to observe the reading.
5. Record the reading in the log book. Report temperatures readings to the nearest 0.5 °C for most applications.

Note: Always clean the thermometer prior to storage and/or use.

Units:

Degrees Celsius (°C) or Degrees Fahrenheit (°F)

Conversion Formulas:

$°F = (9/5\ °C) + 32$ or $°C = 5/9\ (°F - 32)$

16.3 Conductivity (Specific Conductance)

Conductivity is a measure of the ability of an aqueous solution to conduct an electric current. Conductivity is customarily reported in micromhos per centimeter (μmhos/cm) at 25 °C. It is important to note that if the conductivity measurements are for NPDES reporting purposes, the meter and conductivity cell should be verified by comparing against a laboratory meter with a platinum-electrode type conductivity cell.

Equipment available:

- Orion Model 140 conductivity meter

Calibration:

The meter is calibrated in accordance with the manufacturer's instructions by the FEC before it is taken into the field. A two-point calibration verification should be used to ensure the accuracy of the meter. The cell constant of the 014000 series cell is automatically set (0.0609/cm) by the meter. All field conductivity meters are verified against a National Institute of Standards and Technology (NIST) traceable thermometer, the Hanna Instruments CheckTemp 1 or equivalent, at least semi-annually. These verification checks are documented in a logbook and maintained at the Federal Equipment Center (FEC). Labels are placed on the conductivity meters to indicate when the next temperature verification check is required.

Conductivity is affected by temperature; therefore, temperature should be read first so that appropriate adjustments can be made in accordance with the manufacture's instructions and the method. Fresh standards should be obtained and used for each field trip. Discard standard solutions after each calibration verification.

1. Make sure the meter is warmed up as per manufacturer's directions. Verify the meter's internal temperature sensor against a NIST traceable Fisher brand stem-type digital thermometer, or equivalent, and note any differences in your logbook. If the temperature readings agree within ± 4 ° C, apply any necessary correction factor and proceed with measuring the temperature of the standard solutions within 0.5 °C. If the temperatures do not agree within ± 4 ° C, the unit must be repaired or replaced. Substitute the NIST traceable thermometer for temperature readings and apply necessary corrections. Check and record the temperatures of the standards and the samples.

2. Rinse the probe with de-ionized water and blot dry before immersing it in the standard solution. One standard should be close to 1412 μmhos/cm (0.01 M KCL) and the other standard should be in the expected range of the samples being measured.

3. Immerse the probe in the first standard solution (0.01 M KCL) and record the results. The difference between the standard and the measured result is how the cell constant is determined. Document the measurement in the logbook to calculate the cell constant to be used in the calculations if necessary.

4. Rinse the probe, blot dry and immerse it into the second standard solution and record results. If the meter is not accurate to within ± 10% of the second standard, the cell should be repaired or replaced if possible. If this is not possible, the cell constant can be adjusted by pressing the °C.TC.C key until the cursor in right LCD display indicates "TC". Adjust TC to 0.00 by using the up/down scroll keys. Press the °C.TC.C key to select the C mode. Immerse cell into a solution of known conductivity (e.g, 445 μmhos/cm @ 25 °C). Press the up/down scroll keys until the meter indicates the known conductivity of the solution in the left LCD display. The new cell constant will now be shown in the meter C display (right LCD display). Document the readings before proceeding.

Procedures:

1. Collect the sample, check and record its temperature. If possible, allow the sample to come to room temperature (23 to 27 °C).

2. Correct the instrument's temperature adjustment to the temperature of the sample (if required).

3. Immerse the probe in the sample keeping it away from the sides and bottom of the container. It is important that the center portion of the probe be wetted by the sample.

4. Allow meter to stabilize. Record the results in a log book.

5. Rinse probe with de-ionized water.

Units:

The Orion Model 140 conductivity meter has automatic temperature compensation and will read out directly in μmhos/cm corrected to 25 °C. If another meter is used that is not temperature correcting, a correction must be applied. If the sample temperature is below 25 °C, add 2% of the reading per degree. If the temperature is above 25°C, subtract 2% of the reading per degree. Results should be reported to the nearest ten (10) units for readings below 1,000 μmohs/cm @ 25°C and to the nearest one hundred (100) units for reading above 1,000 μmohs/cm @ 25°C.

16.4 Hydrogen Ion Concentration (pH)

The pH is defined as the negative logarithm of the effective hydrogen-ion concentration. For routine work use a pH meter accurate and reproducible to 0.1 pH unit with a range of 0 to 14 and equipped with a temperature-compensation adjustment.

Meter(s) available:

- Orion Model 230A or 290A
- Hydrolab Surveyor II
- YSI 3530, 3500 Water Quality Monitoring System

Calibration: Because of the wide variety of pH meters and accessories, detailed operating instructions cannot be incorporated into this method. Each analyst should become acquainted with the operation of the meter used and follow manufacturer's instructions. The following calibration guidelines are minimum requirements.

The meter is calibrated in accordance with the manufacturer's instructions by the FEC before it is taken into the field. A two-point calibration verification should be used to ensure the accuracy of the meter. All field pH meters are verified against a National Institute of Standards and Technology (NIST) traceable thermometer, the Hanna Instruments CheckTemp 1 or equivalent, at least semi-annually. These verification checks are documented in a logbook and maintained at the FEC. Labels are placed on the pH meters to indicate when the next temperature verification check is required.

Note:

1. Make sure the meter is warmed up as per manufacturer's directions. Verify the meter's internal temperature sensor against a NIST traceable Fisher brand stem-type digital thermometer, or equivalent, and note any differences in the logbook. If the temperature readings agree within ± 4 ° C, apply any necessary correction factor and proceed with measuring the temperature of the standard solutions within 0.5 °C. If the temperatures do not agree within ± 4 ° C, the unit must be repaired or replaced. Substitute the NIST traceable thermometer for temperature readings and apply necessary corrections. Check and record the temperatures of the standards and the samples.

2. The pH of the sample to be tested should be estimated either from historical data or by using a four-color pH indicator paper or equivalent. Using this information, calibrate the pH meter with the two buffers that bracket the expected pH range. Select either pH 4 and 7 or pH 7 and 10 buffer solutions.

3. Rinse the probe with de-ionized water, blot dry and immerse it into the first buffer (pH 7) and calibrate the meter to read the correct pH.

4. Rinse the probe with de-ionized water, blot dry and immerse it into the second buffer and calibrate the meter to read the correct pH. Record the buffer values / temperatures used to calibrate the meter.

5. Rinse the probe with de-ionized water, blot dry and immerse it into the original buffer (pH 7) and read as a sample. If the meter reads within ± 0.1 pH unit of the known value of the buffer, record the value returned by the meter.

6. Rinse the probe with de-ionized water, blot dry and immerse it into the second buffer used (pH 4 or 10) and read as a sample. If the meter reads within ± 0.1 pH unit of the known value of the buffer, record the value returned by the meter.

7. Rinse the probe with de-ionized water and store it in the manufacturer's recommended storage solution. Leave the meter on until all sample measurements are performed and the results are recorded. It is recommended that the meter be checked periodically against the known buffer values if used for extended periods (> 4 hrs).

8. If the meter is turned off, it must be recalibrated.

Procedures:

1. Collect a sample. Measure the temperature prior to measuring the pH.

Note: When the pH meter response is slow, unstable, or non-reproducible, it may be necessary to check the conductivity. If the conductivity is lower than 20 to 30 μmhos/cm then add 1 ml of 1M potassium chloride solution per 100 mls of sample. Recheck the pH and record.

2. Immerse the probe in the sample keeping it away from the sides and bottom of the sample container. Allow ample time for the probe to equilibrate with the sample while gently stirring the sample.

3. While suspending the probe away from the sides and bottom of the sample container, record the pH.

4. Rinse the probe with de-ionized water and store it in a de-ionized water filled container until the next sample is ready.

Operational check:

1. While in use, periodically check the pH by rinsing the probe with de-ionized water, blot dry and immerse it into the pH 7 buffer solution.

2. Perform a post calibration verification at the end of the day and record all measurements.

Units:

Units of pH are Standard Units (SU) and should be read in one-hundredths (0.01) and recorded in tenths (0.1).

Note: If the pH measurements are to be used for RCRA regulatory purposes and when the pH approaches the alkaline end (pH $\geq$ 11.0) of the scale, the pH measurements should be made by a qualified analyst using laboratory quality equipment to control the sample at 25°C $\pm$1°C.

16.5 Turbidity

A nephelometer/turbidimeter is used in comparing the turbidity of liquids by viewing light through them and determining how much light is eliminated.

Meter(s) available:

- Hach 2100P Portable Turbidimeter

Calibration:

1. The turbidimeter is calibrated with Formazin Primary Standards semi-annually by the FEC and a record of the calibration is maintained on file at the FEC. Labels are placed on the turbidimeters to indicate when the next calibration is required. The turbidimeter should be verified with the Gelex secondary standards in the field before each use. The Gelex Secondary Standards are supplied with the instrument, but must be assigned values before use after the formazin calibration. If the instrument readings do not agree within ± 10 % of the Gelex standards, the unit must be recalibrated, repaired or replaced. These verifications should be documented in the inspector's logbook.

2. Turn the meter "ON".

3. Rinse the sample cell 3 times with organic free or de-ionized water.

4. Fill the cell to the fill line with organic free or de-ionized water and then cap the cell.

5. Use a non-abrasive lint-free paper or cloth (preferably lens paper) to wipe off excess water and streaks.

6. Open the cover and insert the cell (arrow to the front) into the unit and close the cover.

7. Press "READ" and wait for the 'light bulb' icon to go off. Record the reading.

8. Using the Gelex standards, repeat steps 4, 5, and 6. Record all measurements (note anomalies).

Procedures:

1. Collect a representative sample or use a portion of the sample that is collected for pH, temperature, or conductivity analysis, and pour off enough to fill the cell to the fill line (about 15 mL) and replace the cap on the cell.

2. Wipe off excess water and any streaks with a soft, lint-free cloth (lens paper).

3. Press I/O and the instrument will turn on. Place the meter on a flat, sturdy surface. Do not hold the instrument while making measurements.

4. Insert the sample cell in the in the instrument so the diamond or orientation mark aligns with the raised orientation mark in the front of the cell compartment. Close the lid.

5. Select manual or automatic range selection by pressing the range key.

6. Select signal averaging mode by pressing the Signal Average key. Use signal average mode if the sample causes a noisy signal (display changes constantly).

7. Press Read. The display will show ---- NTU. Then the turbidity in NTU. Record the result after the lamp symbol turns off.

8. Rinse the cell with de-ionized water.

9.. For the next sample, repeat Steps 1-8.

Operational check:

1. Periodically check the turbidity meter during the day by using the gelex secondary standards provided.

2. Preform a post calibration at the end of the day and record all measurements.

Units:

Turbidity measurements are reported in nephelometric turbidity units (NTUs). It is important to note that if the turbidity measurements are for NPDES reporting purposes, all values above 40 NTU must be diluted with turbidity free water and calculated by multiplying by a dilution factor.

16.6 Salinity

Salinity is the measure of salts of the alkali metals or of magnesium found in water. This measurement is based on the direct proportionality between the magnitude of an induced electric current and the electrical conductivity of the water in which it is induced. Salinity is the total amount of salts (in grams) in 1 Kg of sea water expressed as parts per thousand.

Meters available:

- Beckman Model RS5-3 Portable Salinometer
- Hydrolab Surveyor II
- Scout
- Datasone Salinometer

Calibration/Maintenance:

- Follow the manufacturer's instructions.
- Routinely check the Beckman meter against a resistor matched to the meter.

Procedures:

- The Beckman has an accuracy of ± 0.3 parts per thousand (ppt) salinity, ± 0.05 °C temperature, and ± 0.5 millimhos/cm specific conductance.
- The Hydrolab Surveyor II, Scout, and Datasone Salinometer have an accuracy of ± 0.7 ppt at 1% full scale conductance at ± 0.1 °C.
- These meters are suited for use in brackish to saline waters having a salinity range of 0 to 40 ppt.

Units:

Units are reported as salinity in the nearest tenth of a ppt (0.1 ppt).

16.7 Dissolved Oxygen (DO)

Meter available:

- YSI Models 55, 57 or 58 membrane-covered electrode (ME) DO meter

  Membrane-covered electrode systems utilize a sensing element that is protected by an oxygen-permeable membrane that serves as a diffusion barrier against impurities. The meters for determining the DO in water are dependent upon electrochemical reactions. Under steady-state conditions the current is directly proportional to the DO concentration. Interfacial dynamics at the ME/sample interface are a factor in probe response and a significant degree or interfacial turbulence is necessary. For precision performance, turbulence should be constant.

Inspection:

- Prior to field use, the membrane of the DO probe should be inspected for air bubbles and/or holes. If air bubbles or holes exist, replace the membrane.
- The membrane should be checked for dryness. If the membrane is dry, replace and soak it in analyte-free water prior to calibration of the meter.

Calibration:

- Air calibrate according to the manufacturer's instructions, either in air saturated water or in a water saturated air environment.

- The ME meter can be calibrated against the Winkler method as a QC check if desired.

Procedures:

1. When making measurements, be sure that the ME stirring apparatus is working.

2. Adjust the temperature and salinity compensators (if equipped).

3. Read the dial to the nearest 0.1 mg/l and record the measurement.

To Collect a Sample:

1. When possible, measure the DO in-situ with a field probe; otherwise,

2. Collect the sample by completely filling a 300-ml BOD bottle, stopper and measure the DO with a laboratory type probe.

   Note: Special care should be exercised to avoid entrainment of atmospheric oxygen or loss of DO. The sample should be collected with a DO Dunker (APHA-type) for depths less than five feet below water surface (BWS). A Kemmerer type sampler is recommended for depths greater than five feet BWS.

3. If an APHA-type DO Dunker is not available and a shallow depth sample is needed, a bucket may be used to collect a sample of water. A siphon tube should be coiled into the bucket such that the fill end is nearest the bottom. Using a 300-ml BOD bottle, allow the siphoning sample to fill and overflow the bottle for a minimum of three volumes.

4. If a Kemmerer sampler is used, the BOD sample bottle should be filled to overflowing by inserting the outlet tube of the sampler to the bottom of the bottle. The tube should be withdrawn slowly as the bottle is allowed to overflow three times its volume. Care must be exercised to prevent turbulence or the formation of bubbles when filling the bottle.

Duplicate analyses should agree within ± 0.1 mg/l.

Units:

Units should be reported in mg/l.

Limitations:

- Dissolved inorganic salts are a factor with the performance of DO probes.

  Note: Make note if inorganic salts are present in levels that may represent possible interferences.

- Dissolved oxygen ME probes are temperature sensitive, and temperature compensation is normally provided by the manufacturer (see manufacturer's instructions).

16.8 Total Residual Chlorine

Meter(s) available:

- Pocket colorimeter

8. Specific ion electrode

- Hach DR-100 Colorimetric (DPD) kit -- n,n-diethyl-p-phenylenediamine (DPD) may be used for natural waters or waters treated with chlorine.

  Note: The Hach reagents and colorimeter or spectrophotometer are accepted by the US-EPA for NPDES monitoring if used in accordance with approved procedures. The pre-printed calibration scales provided by the manufacturer are based on factors developed under ideal conditions and are only acceptable if verified. The calibration scale must be initially verified using multiple (4-5) standards and a blank. The calibration scale or curve must be verified at least daily using a blank and one **high** and one **low** standard representative of the linear working range. These standard checks must agree within ±10% of the original scale or a new curve must be prepared. Verification data should be recorded and maintained on file (See Standard Methods).

  Use either 1-cm or 2.5-cm cells depending upon concentration range of the sample.

Inspection:

- Each meter should be visually inspected before and after each use. Report any problems to the FEC.

- Check the battery strength.

- Insure that the reagents are fresh before field trips.

Calibration:

- The calibration scales must be calibrated onsite with a minimum of three points: a blank and two known standards that bracket the expected sample concentrations.

  Note: If the DPD kit is used, the method must adhere to the requirements set forth in Standard Methods.

Reagents/Standards:

- DPD total residual chlorine powder packets.

  Note: The packets deteriorate in the presence of moisture or high temperature. The packets should be discarded if they have caked or have turned brown.

  Always wear gloves when handling the DPD oxalate. Do not ingest the DPD oxalate. If accidentally spilled on skin, rinse off immediately.

- Chlorine demand-free water (See Standard Methods, Method 4500 Cl for directions in preparing the ASTM Standard D1193 "Consumption of Potassium Permanganate").

- Potassium permanganate stock -- Prepare a stock solution containing 891 mgs/1000 mls. Keep stock cool and store in the dark.

- Potassium permanganate intermediate stock 10 ppm – Prepare intermediate stock solution containing 10 mg/l $KMnO_4$ by diluting 10 mls of stock solution to 1 liter.

  Note: The intermediate stock should be stable for approximately 5 days if kept cool and away from light.

- Potassium permanganate calibration standards -- Prepare calibration standards from the intermediate stock solution and/or $KMnO_4$ calibration standard solutions for each day of use. The calibration standards are good for about 2 hours and will fade rapidly (within 15 minutes) if chlorine demand-free water is not used.

Calibration Standard (mg/l)	mls of Intermediate Stock/100 mls
0.05	10.0 of 0.5 mg/l std.
0.10	10.0 of 1.0 mg/l
0.5	5.0 of 10 mg/l
1.0	10.0 of 10 mg/l
2.0	20.0 of 10 mg/l

<u>Procedures: for total chlorine concentrations ranging between 0 - 2 mg/l</u>

1. Fill a clean 2.5 cm cell to the 10-ml mark with a sample.

   Note: The sample should have a pH between 6 and 7 SU. If necessary, adjust with 1N sulfuric acid or 1N sodium hydroxide.

2. Open a DPD total chlorine powder packet and add the contents to the sample cell.

3. Replace the cap on the cell and swirl to mix.

   Note: It is not necessary for all of the particles to dissolve to obtain an accurate reading. The pH of the sample containing the DPD buffer packet must be between 6.2 and 6.5 SU.

4. Allow at least 3 minutes but not more than 6 minutes before moving to the next step (see and follow manufacturer's instructions for reaction times). The reaction times for standards and samples should be as close to each other as possible.

5. Open the light shield, turn the right set knob fully clockwise, and place the 1 cm cell in the left set position of the sample well holder. Press the cell down firmly to seat it in the holder.

6. Hold the button down. While doing this, adjust the left set knob to align the meter needle with the arrow at the extreme left of the scale.

7. Remove the cell from the holder.

8. Fill a clean 2.5 cm sample cell with the sample. Cap the cell and place it into the cell holder. Press it firmly to seat and close the light shield. If measuring high levels, use the 1 cm cell.

9. Set the colorimeter by holding the "ON" button down while adjusting the right set knob to zero. Open the light shield and remove the sample cell.

10. Fill a clean 1-cm sample cell with the solution from step 2, cap the cell, and place into the cell holder.

11. Press the "ON" button down and hold it until the meter stabilizes.

12. Read and record the mg/l of total chlorine from the upper (2.5 cm) scale.

Procedures for total chlorine concentrations ranging between 0 - 3.5 mg/l:

1 - 6. Same steps as previously listed.

7. Rotate the cell to the right position.

8. Fill a clean 1 cm sample cell with the sample, cap the cell, and place it into the cell holder.

9. Set the colorimeter by holding the "ON" button down while adjusting the right set knob to zero. Open the light shield and remove the sample cell.

10. Fill a clean 1 cm sample cell with the solution from step 2, cap the cell, and place it into the cell holder.

11. Press the "ON" button down and hold it until the meter stabilizes.

12. Read and record the mg/l of total chlorine from the upper (1 cm) scale.

Verification:

- Duplicate chlorine residual analyses should agree within ± 0.05 mg/l for the lower range ($\leq$0.5 mg/l), and agree within 0.2 mg/l for the mid-range (0.5 - 2.0 mg/l) and agree within 0.4 mg/l for the high range(2.0 - 3.5 mg/l).

Units:

- mg/l total chlorine

Limitations:

- Do not use with or in the presence of any oxidizing agents, e.g., oxidized manganese interferes with the DPD reagent (1 μg/l MnO_4 ~ μg/l Cl_2).

- Colored matrices may also interfere.

16.9 Flash Point

The following test method is to determine if a volatile material's flash point is within established limits.

Apparatus:

- ERDCO Rapid Tester Model RT-1, Flash Point Analyzer

Calibration:

- The repeatability and reproducibility for this instrument are in accordance with the respective standards:
  - p-xylene 78.0 ± 1.0°F
  - n-butanol 97.9 ± 1.7°F
  - n-undecane 145.4 ± 2.0°F
  - n-hexadecane 270.5 ± 2.0°F

Operational Procedures:

1. Plug in the ERDCO and turn it on.

2. Switch the rocker switch adjacent to the display to Fahrenheit or Celsius display.

3. Press the red temperature preset rocker switch and rotate the red temperature preset knob until the desired temperature appears in the display window (140°F for determining ignitability characteristics). Release the rocker switch and the actual instrument temperature will appear in the display window. The RED light next to the knob should come on indicating the heater is "ON".

   Note: The preset knob for test temperature may have to be reset as the test temperature is approached.

4. If a glass bulb thermometer is used, coat the bulb with a heat transfer compound and insert it into the well in the left side of the test oven. Carefully secure the top of the thermometer in the channel.

5. Open the control valve on the butane cylinder approximately 5 turns and install. Close the control valve and place the cylinder into the instrument's receptacle. Hook the hose to the valve.

6. Open the control valve approximately one turn and light the pilot light located over the square hole in shutter lid. Adjust the pilot light for the minimum flame that will light test the jet. Adjust the test jet for the flame to 4 mm width using the pinch valve knob.

   Note: Immediately above the shutter is a 4 mm referenced milled lid.

7. Make sure that the shutter lid is latched (Closed). Inject 2 cc of the sample into the port between the shutter and the latch handle. Press the 1-minute timer rocker switch until the light goes on, then return the switch to center.

8. When the timer sounds, slide the shutter back slowly (taking about 2 seconds to do this). The material under test will either flash or not flash.

   Note: If a halo develops around the flame, this does not constitute a flash.

9. Lift the lid. Clean out any material which was being tested with Chem-wipes. Also clean the injection port with a pipe cleaner.

Shut Down Procedures:

1. Close the control valve on the butane cylinder.

2. Disconnect the hose.

3. Open the control valve on the butane cylinder approximately 5 turns.

4. Turn the instrument off.

5. IMPORTANT - Clean the instrument (See step 9 above). Allow ample time for the instrument to cool down before storing.

16.10 Halogen Test

This method is used to qualitatively screen wastes for the presence of halogenated compounds.

Test using copper wire and flame:

Equipment:

- Propane fuel cylinder with a torch
- Igniter source (matches, flint/bar striker, etc.)
- Stainless steel rod approximately 1 foot long and ⅛ to ½ inch in diameter

  Note: The smaller diameter rods cool down more quickly.

- Thermally resistant handle or thermally resistant gloves
- 16 or 18 gauge copper wire
- Wire cutters

Procedure:

1. Wrap approximately 4 feet of copper wire around the tip of the rod.

2. Clean the wire and rod tip using the flame of the propane torch.

   Note: When a blue flame with small yellow-orange streaks appears, the wire and rod are clean. Allow the copper wire to become "red" hot during the cleaning process (this takes from ½ to 1 minute).

3. Allow the rod and wire to cool for a minimum of 15 minutes.

   Note: The wire and rod can be immersed in water to speed up the cool down time. This will not bias the results. Allow the water to evaporate completely and the rod tip should be cool to the touch before using it in the test.

CAUTION!
DO NOT IMMERSE A HOT ROD INTO A POTENTIALLY FLAMMABLE MATERIAL

4. Immerse the cooled wire and rod tip into the test material for approximately 10 seconds.

5. Remove the wetted wire/tip from the test material and allow the excess material to drip back into the container.

   Note: Highly viscous material which sticks to the tip may produce a large flame.

6. Place wetted wire into the flame and observe the color produced.

   Note: A bright green flame indicates the presence of halogenated material.

16.11 References

Temperature

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25. Methods for Chemical Analysis of Water and Wastes, US-EPA, 330.5 (1983).

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28. Instruction Manual, DR 100 Colorimeter, Model 41100-02, DPD Method for Chlorine, Hach Company, June 1983.

Salinity

29. Standard Methods for the Examination of Water and Wastewater, 18th Edition, p. 2-47 Method 2520 B (1992).

30. Instruction Manual, RS5-3 Portable Salinometer, Beckman Instruments, Inc., Revised March 1973.

Flash Point

31. Rapid Tester Model RT-1 Technical Manual, Operations and Service, November 1, 1989.

SECTION 17
AIR MONITORING SAFETY EQUIPMENT
CALIBRATION PROCEDURES

17.1 Introduction

This section gives specific procedures to be followed when calibrating air monitoring instrumentation. Calibrations defined in these procedures will result in instrument response accuracy within the capabilities of the instruments. The following practices shall be followed with calibration gases:

- Calibrations should demonstrate proper operation of the monitor and insure that results give an acceptably accurate indication of conditions upon which to base safety decisions and actions.

- Calibration gases shall be certified by their supplier to be of a specified and known concentration.
- Concentrations of calibration gases shall be within a relevant range of response for the air monitors, but will not exceed any flamability or toxic exposure limits.

- Gas cylinders will not be sent to the field if they contain less than one-fifth of their full capacity. Cylinders below the required volume will be utilized in the warehouse for equipment check-out and maintenance.

Calibration mixtures and approximate concentrations for specific air monitors will be as follows:

CALIBRATION GASES		
MONITOR	GAS MIXTURE	CONCENTRATION
Combustible Gas	Pentane in Air	~ 0.75%
Flame Ionization	Methane in Air	~ 75 ppm
Photo-Ionization Detector	Toluene in Air	~ 100 ppm

Calibration Equipment

All calibrations will consist of introducing a gas of known concentration into the monitor at atmospheric pressure. Under no circumstances will it be acceptable to attempt calibration when the monitor is measuring gas concentrations below or above atmospheric pressure.

To insure a stable pressure of the calibration gas, a calibration manifold system will be used. The manifold will consist of a "T" fitting, a Teflon® bag, Teflon® tubing, and fittings. The Teflon® bag is omitted for calibration of the OVA.

The calibration gas cylinder will be connected to the "T" fitting with Teflon® tubing so that the gas will flow directly through the top of the "T" into a Teflon® bag.

The "T" fitting and tubing will be purged with calibration gas prior to connection of the Teflon® bag. The bottom or side port of the "T" will be connected with Teflon® tubing to a stainless steel quick disconnect. Once the Teflon® bag has been filled with gas, the gas flow will be turned off. The monitor's probe will be connected to the manifold via the quick disconnect and allowed to sample the contents of the Teflon® bag.

Calibration Frequency

It is required that the monitors be calibrated each time they are turned on. More frequent calibrations are encouraged if the field investigators determine that field conditions and hazards are warranted. Frequent checking of monitor response or proper setting and operation of alarms is encouraged.

Prior to turning off the monitor, a post calibration check shall be performed. This check will follow the same procedures as the initial calibration except that no adjustments will be made to the monitor. Instead, the response will simply be logged in the field book.

Documentation

Calibrations should be documented in the field log book. The entry needs to include the following information:

CALIBRATION DOCUMENTATION	
Monitor's Identification Number	
Date of Calibration	
Time of Calibration	
Battery Check Response	
Alarm Response	
Instrument Response	
Calibration Gas Concentration	
Fuel Level (FID)	
Operator's Initials	

17.2 MSA Model 260 Combustible Gas and Oxygen Alarm

<u>Introduction</u>

The MSA Model 260 Combustible Gas and Oxygen Alarm is a hand-carried, battery operated instrument.

- It is used to sample atmospheres for combustible gases or vapors and oxygen content and warn the user when pre-determined concentrations of either are reached.
- The monitor will only detect combustible gases and vapors in air. It will **not** indicate the presence of combustible airborne mists or dusts such as lubricating oils, coal dust, or grain dust.
- **THE LACK OF A RESPONSE ON THIS METER DOES NOT GUARANTEE THAT THE ENVIRONMENT IS SAFE.**

<u>Operational Checks</u>

1. Connect the probe line to the monitor's water drop-out bottle. Check the probe fitting and the water drop-out bottle fitting for tightness.
2. Place the monitor's "ON-OFF" switch in the "HORN OFF" position.
   - Note that the monitor's "% OXYGEN" and "% LEL" meters respond upscale, and then stabilize.
   - Note that the oxygen alarm and LEL alarm lights are illuminated, the green flow indicator is flashing, and the "FLOW" indicator float is vibrating audibly.
3. Press the "RESET" button and observe that both "ALARM" lights go out.
4. Press the "CHECK" button and record the battery reading from the "% LEL" meter.
5. Set the "% OXYGEN" meter to read 20.8% using the "CALIBRATE O_2" knob. Set the "% LEL" meter to read zero using the "ZERO LEL" knob.
6. Place the monitor's function switch to the "ON" position.
7. Leak check the monitor by placing your thumb tightly over the probe line inlet. Observe that the monitor's pump stops. Observe also that when the "% OXYGEN" meter falls to approximately 19%, the "ALARM" light illuminates and the alarm horn sounds.
8. Remove your thumb from probe inlet line. When "% OXYGEN" meter returns to 20.8%, press "RESET" button.
9. Rotate the "ZERO LEL" knob clockwise until the "ALARM" light illuminates and the alarm horn sounds. This should occur at about 25% of LEL. Return the LEL meter to a reading of zero and reset the alarms.

Calibration

1. Assemble a calibration manifold as described in Section 17.1 Upon introduction of the calibration gas to the monitor, the LEL response should be approximately 50%. Record the response.

2. Disconnect the monitor from the calibration manifold and reset the alarms.

3. Insure that the function switch is in the "ON" position and that the green flow indicator is steadily illuminated.

4. Attach the probe to the probe line.

17.3 Photovac Microtip Photoionization Detector

Note: Some Microtips are NOT instrinscially safe

Introduction

The detector is capable of measuring concentrations down to about 1 ppm sensitivity for certain compounds. It cannot be used to identify unknown substances, it can only quantify them. Wind and high humidity will affect measurement readings. Foggy or high humidity conditions can cause condensation on the lamp, thus affecting measurements.

As a general rule, the PID should be used to detect aromatic compounds such as benzene, toluene, and styrene; aliphatic amines such as diethylamine; and chlorinated unsaturated compounds such as vinyl chloride and trichloroethylene.

- **THE LACK OF A RESPONSE ON THIS METER DOES NOT GUARANTEE THAT THE ENVIRONMENT IS SAFE.**

- **THE MICROTIP MODEL MP100 IS NOT INTRINSICALLY SAFE**

- **DO NOT USE A NONINTRINSICALLY SAFE MICROTIP IN CONFINED SPACES UNLESS CLEARED WITH AN EXPLOSIMETER**

Operational Information

Turn the instrument on by pressing the back of the power switch. The pump will start and the message **"Warming up now, please wait"** will be displayed. Within three minutes the following information will appear on the display:

Instrument Status Ready	Current Detected Concentration 2000 ppm
008 Event Number	10:15 Feb 15 Time Date

The Microtip then operates automatically. The user reads the concentration directly from the display. The display updates itself each half second.

The following describes the procedure for setup and calibration of the MicroTip. Consult the manual for other information and instructions.

SETUP

Press SETUP and step through the options. Press ENTER to accept the displayed data or enter a numerical value using the keypad and then press ENTER. If no values are entered, the display reverts to normal.

To set up the instrument:

1. Press SETUP.

2. The first step sets the full scale range for the bar graph display, the graph output, the audio output, and the 1 volt analog output. Use the up and down arrow keys to select the 20,200 or 2,000 parts per million (ppm) range.

3. Next the Cal memory is selected. The instrument has five Cal Memories for regular operation and one for High Sensitivity operation. Only one Cal memory can be used at a time. Select Cal Memory 1 with the up and down arrow keys and press ENTER.

4. Next, enter the correct values for the current time. Press ENTER after each value.

5. Enter the numerical values for the day, month, and year. Again press ENTER after each selection.

The instrument is now set for operation.

ALARM

1. Press ALARM.

2. The current alarm is displayed. If the value is correct (5 ppm) wait for the display to revert to normal in 15 seconds or press EXIT.

3. If a new value is to be set, enter the value, and press ENTER.

When an alarm condition is detected the instrument status changes to "Alarm" and remains on until the alarm condition has passed.

CAL

Clean outdoor air is suitable as Zero Gas. Toluene is used as the calibration gas.

1. Press SETUP and check all display information. Select a Cal Memory (usually #1) with the arrow keys and press ENTER. Press EXIT to leave the Setup.

2. Press BATT and record battery voltage.

3. Press ALARM and set the alarm level to 5.0 and then press enter.

4. Press CAL and expose the instrument to Zero Gas (typically ambient air).
Press ENTER and the zero point is set.

5. The instrument then asks for the Span Gas concentration. Enter the known concentration from the toluene gas cylinder (e.g. 97.3 ppm) and press ENTER.

6. Connect the span gas bag to the sample inlet.

7. Press ENTER and wait until the display reverts to normal..

8. The instrument is calibrated and ready for use.

17.4 Toxic Vapor Analyzer (TVA 1000B)

Introduction

The Toxic Vapor Analyzer (**TVA 1000B**) is a portable inorganic/organic vapor monitor. This analyzer uses both a flame ionization detector (FID) and a photoionization detector (PID) to sample and measure concentrations of gases.

Hydrogen Tank for the FID

When the **TVA 1000B** leaves the Field Equipment Center (FEC), the hydrogen tank will be full and the battery will be charged. Ensure that any extra hydrogen tanks taken to the field are filled also.

Note that you must always screw the hydrogen tank into the unit when taking the TVA out of the carrying box. The TVA will not fit back in the box without taking the hydrogen tank out of the unit. Extra hydrogen tanks are available.

Operating Procedures

The **TVA 1000B** is user friendly/menu driven. Pressing the "EXIT" key will take you to the previous menu.

To operate the **TVA 1000B**, follow the procedures listed. The instrument must be **on and warmed up for approximately 30 minutes** prior to calibration. The pump must be ON, the PID lamp must be ON, and the FID must be ignited throughout the warm-up period.

NOTE: If only one of the 2 detectors is desired, calibrate only that detector.

INSTRUMENT STARTUP PROCEDURES

1. Ensure that internal battery is charge.
2. Connect sample probe.
3. Fill/install the hydrogen tank, (left handed thread, turn counter-clockwise until resistance is felt).
4. Turn red H_2 Supply valve to ON position if using FID.
5. Press ON
6. Press CONTROL
7. Press 1=Pump on
8. Press CONTROL
9. Press 2=FID on
10. Press CONTROL
11. Press 3=Ignt
12. Press CONTROL
13. Press 4=PID on

Allow instrument to warm up for approximately 30 minutes.

INSTRUMENT SETUP

While instrument is warming up, check the following:

ALARMS

1. From Main Menu press 2=Setup
2. Press 2=Alarm
3. Press 1=STEL, if needed

Press 1=Both
Enter STEL value, press Enter=Accept

4. Press 2=Low Ceiling
   Press 1=Both
   Set level at 5.0 ppm, press Enter=Accept

5. Press 3=High Ceiling
   Press 1=Both
   Set level at 200 ppm, press Enter=Accept

6. Press EXIT

<u>OTHER</u>

1. Press 6=Other

2. Press 2=Date to verify date, change if needed

3. Press 3=Time to verify time, change if needed

   Other settings should not need to be changed.

4. Press EXIT

<u>CALIBRATION CONFIGURATION</u>

1. Press 1=Calib

2. Press 1=Cfg

3. Press 1=Number span pt
   Verify that value is 1 for both detectors

4. Press EXIT

5. Press 2=Background correct
   Select background correction option, 1=Both, 2=None, 3=PID or 4=FID

6. Press EXIT

7. Press DOWN arrow

8. Press 1=Accept Mode

9. Choose 1=Manual or 2=Auto
   <u>Auto</u> - Instrument analyzes the gas sample until values stabilize and then stores the final value.
   <u>Manual</u> - User monitors gas sample measurements (in counts) and presses ENTER to store the value.

10. Press EXIT

11. Press 2=Save Mode

12. Choose 1=Manual or 2=Auto, User choice, but Manual is recommended.

13. EXIT

14. Press DOWN arrow

15. Press 1=RF calc mode
    Press 1=Factor

16. Press EXIT

<u>SPAN CONCENTRATION</u>

1. Press 2=SpanConc
   DOWN arrow will change units of measure, select ppm with 1 decimal point

2. Press 2=PID and enter concentration of toluene (e.g. 97.3ppm)

3. ENTER=Accept

4. Press 2=SpanConc
   DOWN arrow will change units of measure, select ppm with 1 decimal point

5. Press 3=FID and enter concentration of methane (e.g. 76.5ppm)

6. ENTER=Accept

<u>RESPONSE FACTOR</u>

1. Press 5=RF
   Select RF0: DEFAULT (Response Factor will be 1)
2. ENTER=Accept

<u>CALIBRATION PROCEDURE</u>

If the instrument has been warmed-up for approximately 30 minutes, continue with calibration.

Fill appropriate teflon bags with calibration gases:
<u>Toluene</u> - PID
<u>Methane</u> - FID
<u>Zero Air</u> - Both

1. From Calib Menu Press 3=Zero

2. Press 1=Both

3. Connect Zero Air bag to probe

4. Press Enter=Start
   In Manual mode, after "counts" stabilize press Enter=Accept.
   In Auto mode, instrument will accept value automatically.

5. Press 4=Span

6. Press 2=PID

7. Connect Toluene bag to probe

8. Press Enter=Start
   In Manual mode, after "counts" stabilize press Enter=Accept.
   In Auto mode, instrument will accept value automatically.

9. Press 4=Span

10. Press 3=FID

11. Connect Methane bag to probe

12. Press Enter=Start
    In Manual mode, after "counts" stabilize press Enter=Accept.
    In Auto mode, instrument will accept value automatically.

Calibration Complete

1. Press EXIT

2. From MAIN MENU press 1=Run

3. Check response of each detector by applying the appropriate calibration gases to the instrument. Methane for the FID and Toluene for the PID. Record responses.

4. Instrument is ready to use. To power down the instrument press and hold the OFF key. Also turn the red H_2 supply handle to the OFF position.

5. For more information on multi-point calibration, logging and data transfer, consult manual.

TVA 1000B DISPLAY MENU STRUCTURE

- 1 **RUN**
- 2 **SETUP**
  - *CALIBRATION*
    - CONFIG
      - NUMBER SPAN PTS
      - BACKGROUND CORRECT
      - ACCEPT MODE
      - SAVE MODE
      - RF CALC MODE
    - SPANCONC (Enter Span Gas Conc)
    - ZERO (CALIB)
    - SPAN (CALIB)
    - RESPONSE FACTOR
      - CHANGE
        - NAME
        - VALUE
      - ACCEPT
    - BACKGROUND (CONC UPDATE)
  - *ALARMS*
    - STEL
    - LOW CEILING
    - HIGH CEILING
  - *LOG*
    - NONE
    - AUTO
    - VOC/FE
      - VOC
      - FE
    - CUSTOM
  - *PASSCODE*
    - NEW PASSCODE
    - ENABLE
    - DISABLE
  - *HARDWARE*
    - PROBE DISPLAY
      - BASIC
      - ENHANCED
    - BARCODE READER
      - SELECT READER
        - NONE
        - HP SMART WAND
        - PSC LASER
      - INITIALIZE READER
  - *OTHER*
    - USER ID
    - DATE
    - TIME
    - USER OPTIONS
      - KEY CLICK
      - DISPLAY DELAY
- 3 **INFO**
- 4 **PCLINK/MEMORY**
  - *PC LINK*
    - CHANGE TYPE
    - ESTABLISH LINK
  - *CLEAR ROUTE & LOGGING MEMORY*

17.5 Toxic Vapor Analyzer (TVA 1000A)

Introduction

The Toxic Vapor Analyzer **(TVA 1000A)** is a portable inorganic/organic vapor monitor. This analyzer uses both a flame ionization detector (FID) and a photoionization detector (PID) to sample and measure concentrations of gases.

Hydrogen Tank for the FID

When the **TVA 1000A** leaves the Field Equipment Center (FEC), the hydrogen tank will be full and the battery will be charged. Ensure that any extra hydrogen tanks taken to the field are filled also.

Note that you must always screw the hydrogen tank into the unit when taking the TVA out of the carrying box. The TVA will not fit back in the box without taking the hydrogen tank out of the unit. Extra hydrogen tanks are available.

Operating Procedures

The **TVA 1000A** is user friendly/menu driven. Pressing the "EXIT" key will take you to the previous menu.
To operate the TVA 1000A, follow the procedures listed. The instrument must be **on and warmed up for approximately 30 minutes** prior to calibration. The pump must be ON, the PID lamp must be ON, and the FID must be ignited throughout the warm-up period.

NOTE: If only one of the 2 detectors is desired, calibrate only that detector.

INSTRUMENT STARTUP PROCEDURES

1. Ensure that internal battery is charge.

2. Connect sample probe.

3 Fill/install the hydrogen tank, (left handed thread, turn counter-clockwise until resistance is felt).

4. Turn red H_2 Supply valve to ON position if using FID.

5. Press ON key

6. Wait for self-test diagnostic to complete.

7. Press CONTROL

8. Press 1=Pump on

9. Press CONTROL

10. Press 2=Ignite

11. Press CONTROL

12. Press 3=Turn PID On

Allow instrument to warm up for approximately 30 minutes.

INSTRUMENT SETUP

While instrument is warming up, check the following:

ALARMS

1. From Main Menu press 2=Setup
2. Press 2=Alarms
3. Press 1=STEL, if needed
   Press 1=Both
   Enter STEL value, press Enter=Accept
4. Press 2=Low Ceiling
   Press 1=Both
   Set level at 5.0 ppm, press Enter=Accept
5. Press 3=High Ceiling
   Press 1=Both
   Set level at 200 ppm, press Enter=Accept
6. Press EXIT

INFO

1. From Main Menu press 3=Info
2. Press the UP or DOWN arrows to scroll through information about instrument. Pressing the UP arrow once will show screen with battery status.
3. Press EXIT

OTHER SETTINGS

1. From Main Menu press 2=Setup
2. Press 5=Othr
3. Press 2=Time to verify time, change if needed, if not, press "EXIT"
4. Press 3=Date to verify date, change if needed, if not, press "EXIT"
5. Press 4=User Options
6. Press 1=Key Click
7. Press 1=On or 2=Off, User choice

8. Press 2=Display Delay

9. Press 1=Short

10. Press 3=Calib Mode

11. Press 1=Manual or 2=Auto, User choice, but Manual recommended
    Auto - Instrument analyzes the gas sample until values stabilize and then stores the final value.
    Manual - User monitors gas sample measurements (in counts) and presses ENTER to store the value.

12. Press EXIT
    Other settings should not need to be changed.

13. Press EXIT again to return to SETUP MENU

CALIBRATION MENU

SPAN CONCENTRATION

1. Press 1=Calibration

2. Press 4=GasConc

3. Press 2=PID
   DOWN arrow will change units of measure, select ppm with 1 decimal point.
   Enter concentration of toluene (e.g. 97.3ppm)

4. Press Enter=Accept

5. Press 4=GasConc

6. Press 3=FID
   DOWN arrow will change units of measure, select ppm with 1 decimal point.
   Enter concentration of methane (e.g. 76.5ppm).

7. Press Enter=Accept

RESPONSE FACTOR

8. Press 5=Response Factor

9. Press 1=Both and enter value of 1.00.

10. Press Enter=Accept

CALIBRATION PROCEDURE

If the instrument has been warmed-up for approximately 30 minutes, continue with calibration.

Fill appropriate teflon bags with calibration gases:
Toluene - PID
Methane - FID
Zero Air - Both

1. From Calibration Menu Press 1=Zero

2. Press 1=Both

3. Connect Zero Air bag to probe

4. Press Enter=Start
   In Manual mode, after "counts" stabilize press Enter=Accept.
   In Auto mode, instrument will accept value automatically.

5. Press 2=Background

6. Press 1=Both

7. Press Enter=Start
   In Manual mode, after "counts" stabilize press Enter=Accept.
   In Auto mode, instrument will accept value automatically.

8. Press 3=Span

9. Press 2=PID

10. Connect Toluene bag to probe

8. Press Enter=Start
   In Manual mode, after "counts" stabilize press Enter=Accept.
   In Auto mode, instrument will accept value automatically.

9. Press 3=Span

10. Press 3=FID

11. Connect Methane bag to probe

12. Press Enter=Start
   In Manual mode, after "counts" stabilize press Enter=Accept.
   In Auto mode, instrument will accept value automatically.

Calibration Complete

1. Press EXIT

2. Press EXIT again.

3. From MAIN MENU press 1=Run

4. Check response of each detector by applying the appropriate calibration gases to the instrument. Methane for the FID and Toluene for the PID. Record responses.

5. Instrument is ready to use. To power down the instrument press and hold the OFF key. Also turn the red H_2 supply handle to the OFF position.

6. For more information on multi-point calibration, logging and data transfer, consult manual.

17.6 Century Model OVA-128 Organic Vapor Analyzer

Introduction

The Century Model OVA-128 Organic Vapor Analyzer (OVA) is designed to detect organic compounds in air.

- It uses a hydrogen flame ionization detector (FID) as its detection principle. This detector allows the monitor to respond to a wide variety of organic compounds, but limits its sensitivity to around 10 ppm under ideal circumstances. The OVA's best response is to single-bonded hydrocarbons such as methane and dichloroethane.

- THE LACK OF A RESPONSE ON THIS METER DOES NOT GUARANTEE THAT THE ENVIRONMENT IS SAFE.

Operational Checks

1. Connect the hand readout unit's electrical and pneumatic fittings to the side pack assembly.

2. Connect probe to the hand readout unit.

3. Place the "PUMP" switch in the ON position. Check the battery's condition by placing the "INSTR" switch to the BATT position and observe the response on the hand readout unit.

4. Place the "INSTR" switch in the ON position.

5. Set the "Calibration Switch" to the "X10" position.

6. Use the "CALIBRATE" knob to set the readout to a reading of 6. Using the Alarm Level Adjustment Knob on the back of the readout, obtain an audible response to the reading of 6.

7. Set the "Calibration Switch" to the "X1" position.

8. Use the "CALIBRATE" knob to set the readout to a reading of 0, and check to insure that the flame-out alarm is audible.

9. Place the "PUMP" switch in the ON position and observe that the "SAMPLE FLOW RATE" indicator shows flow.

10. Open the "H_2 TANK VALVE" and the "H_2 SUPPLY VALVE" one turn each. Allow fuel to flow for about 1 minute.

11. Press ignitor button and hold until readout unit indicates ignition.

12. Use "CALIBRATE" knob to set readout to a reading of 0.

    - Note: a small positive offset above 0 may be necessary to prevent activation of the flame-out alarm.

Calibration

1. Assemble a calibration manifold as described in Section 17.1 using methane as the calibration gas. (Remember to omit the use of a Teflon® bag.)

2. Set the "CALIBRATION SWITCH" to the appropriate position for the concentration of the calibration gas. (usually X10)

3. Connect the instrument's probe to the calibration manifold and allow it to sample the calibration gas.

4. The readout should indicate a value which is close to the concentration of the calibration gas plus any offset which may have been added.

5. Place the "CALIBRATION SWITCH" in the "X1" position before entering the site.

17.7 Ludlum Model 3 Radiation Survey Meter

Introduction

The Ludlum Model 3 is a portable radiation survey meter. The instrument is set for 900 volt Geiger-Mueller Tube (GMT) measurement of beta and gamma radiation. The range of the meter is from 0 to 200 milliroentgen per hour. It is important that the operator realizes that this meter will not respond to most alpha radiation.

- THE LACK OF A RESPONSE ON THIS METER DOES NOT GUARANTEE THAT THE ENVIRONMENT IS SAFE.

Operational Checks

1. Place the multifunction switch in the "BAT" position and note the meter's reading.

2. Place the multifunction switch in the "X0.1" position, the F/S switch in the "S" position, and the "AUDIO" switch in the "ON" position. Note that an audible clicking sound can be heard while the meter is counting. After a few seconds, press the "RES" button and note that the meter returns to zero.

Calibration

1. Read and record the background radiation level.

2. Place the GMT probe flat against the casing of a certified Sr90 standard.

3. Adjust the multifunction switch until the meter reading remains on scale.

4. Read and record the meter's response.

5. Calculate the detector's efficiency as follows:

$$E = \frac{\text{Meter Reading - Background}}{\text{Activity}}$$

6. Check to insure that the calculated efficiency is within $\pm$ 0.1 of the efficiency rating placarded on the meter.

7. Set the multifunction switch to "X0.1" before entering the site.

17.8 MiniRAE

Introduction

The **MiniRAE (RAE)** is a programmable **photoionization detector (PID)** that measures **organic** vapors in hazardous environments. It incorporates a sampling pump and data download capabilities for continuous toxic monitoring, site survey, and leak detection. The RAE can measure double-bonded organic vapors with its supplied 10.6 eV gas discharge lamp. The RAE is calibrated with toluene.

- The RAE is intrinsically safe.

- Only key steps are listed below. Almost all set-up functions on the RAE have been pre-set. The keys you will need to press will generally deal with calibration.

- The battery on the RAE drains slowly even when turned off. If the unit has not been charged for 4-5 days, the battery voltage will be low. If the unit is left to charge overnight, it will automatically shut itself off when fully charged.

- Only operate the RAE in the survey mode. The RAE has been pre-set to automatically start **in the survey mode.**

Operating Procedures

1. Power On/Off

   To Turn On the RAE press the [**on**] key. The audio buzzer will beep once and the display will show "HG-x.xx" or "Su-x.xx" to indicate the operating mode and software version number. The unit will **then go through a self-diagnostic routine** to check the key components of the unit. A ".diag.." message will be displayed with a red back light turned on while the self-diagnostic routine is executing. The red LED and back light will flash once and the buzzer will beep once to ensure that they are functional. The sampling pump will be turned on and start to draw air sample.

   To turn Off the RAE press the [**on**] key. The message "off" will flash on the LED display; press the [**enter**] key to confirm and the unit will be turned off. Pressing any other key will return the unit to normal operation.

2. The RAE can display five different readings: instantaneous gas concentration, STEL, TWA, and peak and battery voltage. Most of these functions have either been pre-set or do not apply to most Branch surveys. Only **press [enter]** to scroll through each display.

3. Alarm Signal - The built-in microcomputer constantly updates and monitors real time gas concentrations and compares it with the programmed alarm limits. **Whenever the concentration exceeds any of the preset limits (5 ppm),** the alarm buzzer and red flashing LED will be activated immediately to warn the user of the alarm condition.

   Whenever the battery voltage falls below 5.5 volt (6.3v or higher is normal) or the UV lamp or sensor module fails, the unit will also activate the buzzer and red LED alarm signal.

   In the Survey Mode, the alarm signal is proportional to the level of the gas concentration. Therefore, when the gas concentration exceeds preset limits (5 ppm), the alarm signal may very from a single beep and a single flash per second to a rapid 7 beeps and 7 flashes per second when the high threshold level has been exceeded. The higher frequency of alarm signal indicates higher gas concentrations.

4. Back Light - The LCD display is equipped with a red LED back light to assist the readings under poor lighting conditions. This back light can be turned on by pressing the [**up**] key. When the back light is already on, pressing the [**up**] key will turn it off.

5. Charging the RAE - On the back side of the RAE is a battery charging jack which is normally covered by a protective rubber cover. Open the rubber cover and connect the AC adapter (or the automotive DC charging adapter, depending on the power source to the charging jack). There is a bi-colored LED inside the LED window which will provide an indication of the charging status:

Red	- battery is being charged
Green	- charging is completed
No light	- bad connection or defective battery

   Plug in the AC (or DC) adapter which will turn on the red charge status LED first. If the battery is fully charged, it will turn to green quickly. A completely discharged battery will be charged to its full capacity within 10 hours

Calibration

In the survey mode, the user may re-calibrate the RAE. This is a two-point calibration process using **Zero Gas** and a **Standard Reference Gas**.

1. First, a zero gas which contains no detectable organic vapors is used to set the zero point **(CO)**.

2. Second, a standard reference gas is used to set the second point of reference **(C1)**.

Zero gas Calibration

Use a gas bag (1 liter) and zero concentration gas from your air box.

1. Fill the gas bag with zero concentration gas. Zero gas calibration option is the 5th menu option. Display shows **CO** xxx.x where x.xxx is the gas reading based on current calibration of the instrument.

2. Attach the gas bag to the inlet tube and open the bag so that the instrument can begin pumping the zero concentration gas. The display should be reading zero.

3. If this reading is not zero, press the **[enter]** key to zero it. If the reading still shows a small value after a few seconds, press the **[enter]** key again to zero it. Repeat this process until the reading is stabilized around zero or 0.1 ppm. This completes the zero gas calibration. **Press the [menu] key to exit zero gas calibration while the bag is still on the instrument.**

Enter Standard Calibration Gas Value

1. Enter standard gas value option is the 6th menu option.

2. If the concentration of the standard calibration gas to be used is the <u>same</u> as the displayed value, **press [enter] key 4 times to accept the displayed calibration value one digit at a time and move to the next step.**

3. If the concentration of the standard calibration gas to be used is **<u>different</u>** from the displayed value, the user needs to enter the new value. Starting from the left most digit of the displayed value, use the **[up]** or **[down]** arrow key to change the digit value and **[enter]** to confirm the digit.

4. Now the standard calibration gas value is entered.

   Display shows a flashing message of "GAS ON" to remind the user to turn on the standard calibration gas bottle now. After the gas bottle is turned on, press **[enter]** key to continue the standard calibration procedure.

Standard Gas Calibration Procedure

1. Insert the instrument probe into the calibration gas bag (bag should be at least 1 liter) that is filled with **toluene.**

2. Display shows a flashing message of "GAS ON".

   Press the **[enter]** key, the display should show CAL.... for about 30 seconds while the instrument performs calibration. Afterwards, the display shows C1 xxx.x where C1 indicates that this is the standard calibration gas and xxx.x is the actual gas reading in ppm based on the new calibration data.

   Note: The reading should be very close to the value of the calibration gas. If the reading is higher or lower than the standard gas value and continues to rise slowly, it means that the calibration gas has not yet stabilized. Wait a few seconds until the reading stabilizes and then press the **[enter]** key again. Every time the **[enter]** is pressed, the instrument measures the current gas concentration and calibrate accordingly.

3. Press the **[menu]** key to exit the standard gas calibration procedure and move to next menu item.

4. Disconnect the calibration gas bag.

SECTION 18
WASTEWATER FLOW MEASUREMENT

18.1 Introduction

The measurement of flow with surface water and wastewater sampling is essential to almost all water pollution control activities. Activities such as water quality enforcement studies, NPDES permit compliance monitoring, water quality monitoring, municipal operation and maintenance investigations rely on accurate flow measurements. The importance of obtaining accurate flow data cannot be overemphasized, particularly with respect to enforcement investigations since these data will be used as evidence in enforcement cases. NPDES permits often limit the quantity (mass loading) of a particular pollutant that may be discharged, and calculations of mass loadings are also frequently necessary for water quality studies and other purposes. As much attention and care should be given to flow measurement in the design of a sampling program as to the collection of samples and their subsequent laboratory analysis.

The basic objectives of this section are to:

- outline standard practices with respect to wastewater flow measurements during water enforcement and NPDES compliance monitoring activities and other studies where wastewater flow measurements are required;
- outline standard practices for obtaining surface water flow measurements during water quality surveys;
- present acceptable, commonly used flow measurement techniques; and
- present general and specific quality assurance procedures for flow measurement equipment and techniques.

A complete discussion of all available flow measurement techniques and the theory behind them is beyond the scope of this section. However, most of the commonly used techniques are covered in general terms. A comprehensive list of references is included at the end of this section, and a detailed discussion of flow measurement techniques may be found in the references.

18.2 Wastewater Flow Measurement

18.2.1 Introduction

The USDI Water Measurement Manual (1) is a standard reference for details on checking the installation of primary open channel flow devices. Basic guidance for making wastewater flow measurements and a basic description of all acceptable wastewater flow measurement systems are given in the NPDES Compliance Inspection Manual, September 1984 (2). This manual shall be used as Branch guidance for such measurements.

18.2.2 Site Selection

It is the field investigator's responsibility to ensure that the wastewater flow measurement system or technique used measures the total wastewater discharged (described by the NPDES permit, if applicable). All recycled wastewaters must be accounted for so that reported flows accurately reflect the volume of wastewaters discharged. The location of the wastewater flow measurement equipment should satisfy these criteria, be consistent with NPDES permit requirements, and measure the actual flow.

18.2.3 Flow Measurement Systems

Flow may be measured on an instantaneous or a continuous basis. A typical continuous system consists of a primary flow device, a flow sensor, transmitting equipment, a recorder, and a totalizer. Instantaneous flow measurements can be obtained without using such a system.

The heart of a typical continuous flow measurement system is the primary flow device. This device is constructed to produce predictable hydraulic responses which are related to the flow rate of water or wastewater through it. Examples of such devices include weirs and flumes which relate water depth (head) to flow, Venturi and orifice type meters relate the differential pressure to flow, and magnetic flow meters relate induced electric voltage to flow. Standard primary flow devices have undergone detailed testing and experimentation, and their accuracy has been verified.

A flow sensor is required to measure the particular hydraulic responses of the primary flow measurement device and transmit them to the recording system. Typically, sensors include ultra-sonic transmitters, floats, pressure transducers, capacitance probes, differential pressure cells, electromagnetic cells, etc. The sensor signal is generally converted using mechanical, electro mechanical, or electronic systems into units of flow which are recorded directly on a chart or transmitted into a data system. Systems which utilize a recorder are generally equipped with a flow totalizer which displays the total flow on a real time basis.

Studies that need continuous flow measurements require a complete system. Instantaneous flow measurements do not necessarily dictate the use of any portion of such a system. Techniques which are described later in this Section are available for measuring instantaneous flows with portable equipment.

An important consideration during wastewater studies is that the investigator may want to obtain continuous flow data at a facility where only instantaneous flow data are being measured. If an open channel primary flow device is utilized for making instantaneous measurements, only the installation of a portable field sensor and recorder is necessary. If, on the other hand, the facility being investigated does not utilize a primary flow device, and a continuous flow record is desired, a portable primary flow device will have to be installed. Field investigators have open channel equipment available for field use. These devices should be installed according to the manufacturer's specifications.

Wastewater flow measurement systems are generally very accurate. Any system that cannot measure the wastewater flow within $\pm$10 percent of the actual flow is considered unacceptable for use in measuring wastewater flow.

18.2.4 Use of Existing Flow Measurement Systems

The installation of systems to measure wastewater flows can be time consuming, particularly if a primary device is not available. Therefore, field personnel can use existing facility primary flow devices and flow measurement systems when the accuracy of these devices and the system can be verified. The objective of this section is to outline the responsibilities of field personnel in verifying the accuracy of existing primary flow devices and systems.

The field investigator must verify that an existing facility flow measurement system (including primary flow device) utilized to measure wastewater flows conforms with recognized design and installation standards, and any deviation from standard conditions shall be documented. The accuracy of the primary flow device should be checked by making an independent flow measurement. If there is no usable or existing primary flow measuring device or if the device has been mislocated, the investigator shall attempt to install a portable primary flow device.

If the discharger's flow measurement system is accurate within ± 10 percent of the actual flow, the investigator can use the installed system. The accuracy of flow sensors and recorders for open channel flow devices can be checked by making an instantaneous measurement utilizing the primary flow device and comparing this against the recorder reading. In addition, EPA flow equipment can be installed to check facility totalizer readings. The chart recorder should be checked to verify that the time and scale are correct.

If non-standard primary flow devices are being used, data supporting the accuracy and precision of the methods being employed should be provided by the discharger. Deficiencies should be recorded by the investigator, and the discharger should be informed that the equipment should be calibrated as soon as possible.

18.2.5 Specific Techniques

This section outlines and familiarizes the field investigator with the most commonly used methods for wastewater flow measurements and the primary devices that will be encountered during field studies. Volumetric and dilution techniques are presented at the beginning of this section since they are applicable to both open channel and closed conduit flow situations. The remaining methods are grouped under categories dealing with open channels and closed conduits. The general method of checking individual primary flow devices is given, where applicable. Several estimation techniques are presented. However, it should be recognized that flow estimates do not satisfy NPDES permit monitoring requirements unless the permit specifically states that this is permissible. The following methods are included only to enable the field investigator to make accurate flow estimates when necessary.

<u>Volumetric Techniques</u>

Volumetric flow measurement techniques are among the simplest and most accurate methods for measuring flow. These techniques basically involve the measurement of volume and/or the measurement of time required to fill a container of known size.

<u>Vessel Volumes</u>

The measurement of vessel volumes to obtain flow data is particularly applicable to batch wastewater discharges. Accurate measurements of the vessel volumes and the frequency that they are dumped are all that is required. An accurate tape to verify vessel dimensions and a stop watch are the only required field equipment. The <u>NPDES Compliance Inspection Manual</u> (2) is a useful reference on the equations for calculating volumes of various containers.

<u>Sump Pumps</u>

This measurement is made by observing the sump levels when the pumps cut on and off and calculating the volume contained between these levels. This volume, along with the number of pump cycles, will give a good estimate of the daily wastewater flow. The inspector must also account for the quantity of wastewater that flows into the sump during the pumping cycle.

<u>Bucket and Stop Watch</u>

The bucket and stop watch technique is particularly useful for the measurement of small wastewater flows. It is accurate and easy to use. The only equipment required to make this measurement is a calibrated container (bucket, drum, tank, etc.) and a stop watch. A minimum of 10 seconds to fill the container is recommended. Three consecutive measurements should be made, and the results should be averaged.

Dilution Methods

Dilution methods for water and wastewater flow measurements are based on the color, conductivity, fluorescence, or other quantifiable property of an injected tracer. The dilution methods require specialized equipment, special attention to detail by the investigator, and are time consuming. Dilution methods are described in the EABSOP, Section 14.2.3. (3)

18.2.6 Open Channel Flow Measurements

Measurement of wastewater flow in open channels is the most frequently encountered situation during field investigations. An open channel is defined as any open conduit, such as a channel or flume, or any closed conduit, such as a pipe, which is not flowing full. The most commonly encountered methods in measuring open channel wastewater flows are described in this section. Several flow estimation techniques are also presented.

Measurement accuracies quoted in this section apply only to the specific method or to the primary flow device being discussed. The total error involved in a continuous flow measurement system, which is the sum of the errors of each component, is beyond the scope of this discussion. The reader is referred to the list of references at the end of this chapter for such a discussion.

Weirs

A weir is basically defined as an overflow structure built according to specific design standards across an open channel to measure the flow of water. Equations can be derived for weirs of specific geometry which relate static head to water flow (discharge). Weirs are generally classified into two general categories; broad crested and sharp crested.

Broad crested weirs take the following form; $Q=CLH^{3/2}$. Values for the coefficient C are given in hydraulic handbooks (4,5). Broad crested weirs can only be used to calculate instantaneous flows.

Sharp crested weirs are constructed in a wide variety of shapes and the most commonly encountered are V-notch, rectangular, and Cipolletti weirs. If such weirs are constructed as outlined in the USDI Water Measurement Manual (1), they are considered standard primary flow devices.

All weirs should be inspected to determine if the weir installation and construction conform to the conditions given in the USDI Water Measurement Manual (1), and provide a uniform influent flow distribution, and that the weir is placed squarely across the channel perpendicular to the direction of flow. Useful tools for checking weir construction and installation include a carpenter's level, a framing square, a measuring tape, a staff gage, or surveyors level and rod. Problems observed during the inspection or study should be noted in the field records or log book.

A set of weir tables is necessary for calculating flows. The USDI Water Measurement Manual (1), the Stevens Water Resource Data Book (6), and the ISCO Open Channel Flow Measurement Handbook (7) contain a complete set of tables.

Flumes

Conditions that must be met in a flume are similar to those that occur at a weir or spillway crest since water passing through the throat should not be impeded by downstream conditions (e.g., constrictions, bends in channel, obstructions). There are several types of flumes (e.g., Palmer-Bowlus, Cutthroat, H, and Trapezoidal) but the most widely used is the Parshall flume. The Parshall flume is considered a standard primary flow device when constructed and installed as outlined in the USDI Water Measurement Manual (1). A complete discussion of other types of flumes is given in references 8, 9, 10, and 11.

All flumes should be inspected to determine if entrance conditions provide a uniform influent flow distribution, the flume dimensions conform to those given in the USDI Water Measurement Manual (1), the floor of the flume at the throat section is level, and the throat section walls are vertical. Useful tools for checking the construction and installation of Parshall (and other) flumes include a carpenter's level, a framing square, and a measuring tape. The flume should be closely examined to determine if it is discharging freely. If there is any question about free discharge, the downstream head (Hb) should be measured and compared to the head at the proper location (Ha) in the converging section. A staff gage is useful for making head measurements. Any problems observed during the inspection or study should be noted in the field log book.

A set of flume tables is necessary for calculating flows. The USDI Water Measurement Manual (1), the Stevens Water Resources Data Book (6), and the ISCO Open Channel Flow Measurement Handbook (7) contain a complete set of tables. The explanatory material accompanying these tables should be read and understood before they are used. In many cases, tabulated flow values are given for measured heads that are not within the usable measurement range.

Open Flow Nozzles

Open flow nozzles such as parabolic or Kennison nozzles are factory calibrated and are ordinarily supplied as part of a flow measurement system. Calibration and installation information for each nozzle should be supplied by or obtained from the manufacturer. The accuracy of these devices is reported to be often better than $\pm$ 5 percent of the indicated flow (9). A volumetric flow measurement may be used to check accuracy of this device if flow volumes are not excessive.

Velocity-Area Method

The basic principal of this method is that the flow in a channel (cubic feet/second) is equal to the average velocity (feet/second) times the cross sectional area (square feet) of the channel. The velocity of the water or wastewater is determined with a current meter. The area of the channel is either measured or calculated using an approximation technique. Refer to Section 18.3 for Surface Water Flow Measurements.

18.2.7 Closed Conduit Flow Measurements

The accuracy of closed conduit flow measuring devices may be difficult to verify. Occasionally, it may be necessary to verify accuracy by making an independent flow measurement, preferably using a dilution technique (EABSOP, Section 14.2.3) (3). Below are some of the more commonly used closed conduit devices.

Venturi Meter

The Venturi meter employs a conversion of static head to velocity head whereby a differential is created that is proportional to flow. The typical accuracy of a Venturi meter is at 1 to 2 percent (9, 10, 11and 12).

Orifice Meter

The orifice meter is a pressure differential device that measures flow by the difference in static head. Orifice meters require from 40 to 60 pipe diameters of straight pipe upstream of the installation. They can be accurate, e.g., within 0.5 percent, although their usable range is limited (9).

Flow Nozzle

The basic principle of operation is the same as that of the Venturi meter. The flow nozzle has an entrance section and a throat, but lacks the diverging section of the Venturi meter. Flow nozzle accuracies can approach those of Venturi meters (9).

Electromagnetic Flow Meter

The electromagnetic flow meter operates according to Faraday's Law of Induction where the conductor is the liquid stream, and the field is produced by a set of electromagnetic coils. The accuracy of the device is within ± 1 percent of full scale (9).

Other Closed Conduct Devices

References for other closed conduit flow measurement methods such as acoustic flow meters, trajectory methods, pump curves, and water meters can be found in the NPDES Compliance Inspection Manual (2).

18.3 Surface Water Flow Measurements

18.3.1 Introduction

Surface waters are considered to be open channels for flow measurement purposes. Where installation of a primary flow device is practical, open channel flow measurement shall adhere to Section 18.2.6. Where installation of a primary flow device is not practical, flow measurements shall be made using stream gaging techniques.

Where practical, flow data and/or rating curves shall be obtained from existing permanent stream gaging stations maintained by the USGS, Army Corps of Engineers, or other federal or state agency. Where permanent stations do not exist, flow may be measured using stream gaging techniques. In making stream gaging measurements, Branch personnel shall utilize the procedures outlined in the USGS publication *Discharge Measurements at Gaging Stations* (8) (1) select the flow measurement site, (2) perform stream gaging, and (3) calculate flow. The EABSOP Section 14.2.6 (3) also describes current measurement techniques. If a station is to be used more than one time during a water quality survey, a rating curve may be developed for that station. A rating curve is constructed by making a series of independent flow measurements and simultaneous tape down or staff gage measurements for the same section of a particular station at different water levels and plotting the resulting data pairs on a semi-log graph. At least two (preferably three) flow measurement-tape downs shall be made to develop a rating curve.

Available current meters for conducting stream gaging include vertical-axis mounted Price AA and Price pygmy meters. For wadeable streams, these meters may be deployed using a top-setting wading rod. For non-wadeable streams, a Price AA meter may be deployed on a weighted line using a bridge rig system. Depth may be determined using Raytheon or Lowrance fathometers, taken from a standard top setting wading rod, or by taking the difference of tape down measurements of the river bottom and surface. Width measurements may be made using a Lee-Au galvanized steel tag line segmented into equal lengths, steel tapes, or cloth tapes.

18.4 Quality Assurance Procedures

Techniques and procedures for making wastewater and surface water flow measurements are outlined in this section. The USDI Water Measurement Manual (1), the USGS publication Discharge Measurements at Gaging Stations (8), the EPA NPDES Compliance Inspection Manual (2) and a set of weir and flume tables shall be supplied to all field investigators. However, the measurements of wastewater and water flows require considerable experience. Therefore, no field investigator shall make flow measurements until they have had at least six months of actual field experience and has performed these measurements under the supervision of a senior field investigator.

Wastewater flow shall be expressed in million gallons per day (mgd) or the metric equivalent (m^3/day). Stream flow shall be expressed in cubic feet per second (second feet) or the metric equivalent (m^3/sec). Time records associated with flow measurements shall be kept in local time, shall be made in the 2400 hour military time format, and shall be recorded to the nearest five minutes.

All flow measurements conducted shall be documented in field records. All measurements shall be traceable both to the individual making the measurements and the equipment utilized. All field equipment shall be operated, calibrated, and maintained according to manufacturer's specifications. All equipment shall be visually inspected prior to deployment to ensure proper operation.

18.5 Equipment

Equipment available for the measurement of surface water or wastewater flows is categorized as follows: water level/stage hardware and recorders, velocity measuring equipment and assemblies, and direct flow measurement equipment and instrumentation.

The hardware available to determine the rise and fall of a water surface with time (the water stage) includes the following recording devices: Stevens Model F horizontal drum recorders, Stevens Model A-71 continuous strip chart recorders, Stevens Encoder Recorders, and ISCO Model 2870, 3210, and 3230 flow meters. Non-recording equipment available includes vertical staff gages and tape-down systems (see Section 15).

Instruments and equipment available to make velocity cross-sectional area measurements include current meters and sounding (depth) equipment. The current meters available are the vertical-axis mounted Price AA and Price pygmy meters (including direct readout meters), and ENDECO solid state memory current meters. Sounding (determination of depth) is accomplished using recording fathometers or with a standard top setting wading rod. Width measurements are made using a galvanized steel tag line which is segmented into equal divisions of length by metal beads or steel tapes.

The equipment available for direct flow measurement includes the following primary devices available for installation: V-notch weir plates and rectangular weir plates. The corresponding conversion of water level to flow rate can be accomplished instantaneously from stage/staff gage readings corresponding to the primary flow device in use, or by instantaneous readings of the available recording flow meter systems. The continuous recording systems presently available are the ISCO Model 2870, 3210, and 3230 recording flow meters.

18.6 REFERENCES

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7. ISCO Open Channel Flow Measurement Handbook, Second Edition, Second Printing, Instrumentation Specialists Company: Lincoln, Nebraska, 1985.

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10. A Guide to Methods and Standards for the Measurement of Water Flow, United States Department of Commerce, National Bureau of Standards, NBS Special Publication 421, 1975.

11. Wells, E. A. and H. B. Gotaas, "Design of Venturi Flumes in Circular Conduits," American Society of Civil Engineers, 82, Proc. Paper 928, April 1956.

12. American Society of Testing Materials, 1985 Annual Book of ASTM Standards, Volume 11 - Water, American Society of Testing Materials: Philadelphia, Pennsylvania, 1985.

SECTION 19
SOIL GAS SAMPLING

PERFORMANCE OBJECTIVE:

- To present the standard operating procedures and sample collection methodologies for conducting soil gas sampling.

19.1 Introduction

This section discusses the sample collection procedures used for conducting soil gas sampling in Region 4. These procedures include both manual implantation of passive devices (GORE-SORBER® Modules) as well as direct push (Geoprobe®) installations for both grab sampling and long term, permanent installations.

19.1.1 GORE-SORBER® Implants

Soil gas screening surveys may be conducted with GORE-SORBER® Modules (patented passive soil vapor sampling devices). Organic compounds commonly detected using GORE-SORBER® Modules include fluorinated and chlorinated solvents, straight- and branched chain aliphatics, aromatics, and polycyclic aromatic hydrocarbons (PAHs). Many of these compounds are associated with a wide range of petroleum products, including gasoline, mineral spirits, heating oils, creosotes, and coal tars. GORE-SORBER® Screening Surveys have also been used successfully to screen for nitroaromatic explosives.

Description Of GORE-SORBER® Screening Modules

A typical GORE-SORBER® Screening Module consists of several separate GORE-SORBER® passive sorbent collection devices (sorbers). A typical sorber is 15 to 25 millimeters (mm) long, with a 3 mm inside diameter (ID), and contains 40 milligrams (mg) of a suitable granular adsorbent material depending on the specific compounds to be detected. Typically, polymeric and carbonaceous resins are used for their affinity for a broad range of VOCs and SVOCs. The sorbers are sheathed in the bottom of a one (1) foot length of vapor-permeable insertion and retrieval cord which is fashioned with a loop. This construction is termed a GORE-SORBER® module. Both the retrieval cord and sorbent container are constructed solely of inert, hydrophobic, microporous GORE-TEX® expanded polytetrafluoroethylene (ePTFE, similar to Teflon® brand PTFE). The loop is used as a means of tying the module to a string for installation and retrieval.

Module Installation

1. Drive/drill narrow pilot hole at desired location. Ideally, this hole should be no more than 1 inch in diameter. Typical depth is two to three feet below ground surface.

2. Wearing clean latex gloves, remove the module from it's numbered container and re-seal the jar, verifying that the number on the container corresponds to the number on the module tag.

3. Measure and cut a section of cord of sufficient length to reach from the bottom of the sample hole to the cork to be used to seal the hole.

4. Tie one end of the cord to the loop in the module, and tie the other end of the cord to a screw-eye in the cork used for sealing the hole.

5. Place insertion rod into the pre-cut pocket at the base of the module and lower it into the hole. If you encounter resistance remove the module and enlarge the hole and re-insert the module.

6. Once deployed to the desired depth, press the insertion rod against the side of the hole and twist slightly to release the module. Remove the rod and push any excess cord into the pilot hole and plug it with the cork.

7. Indicate the module number, date and time of installation and any pertinent comments on the installation/retrieval log and in the investigation field book. Write the module serial number on the site map adjacent to the appropriate map location.

Module Retrieval

1. Following the module exposure period (usually 10-14 days) identify and check each module location in the field using the site map.

2. Remove the cork with a penknife or cork screw. Grasp the cord and pull the module from the ground; **verify the module ID number**. Cut off and discard the cork and cord. Place the entire module in its labeled container and tightly secure the lid.

3. Replace the sample container in the box. Where possible, please attempt to keep modules in numbered sequence to expedite sample check-in and processing.

4. Complete the module retrieval date/time on the installation/retrieval log.

5. Do not use Styrofoam "peanuts" as packing material. Bubble packing is acceptable. When packing for shipment, take extra precautions to keep boxes dry.

6. Return the samples with insertion rod and paperwork (preferrably by overnight courier) to:

   Screening Modules Laboratory
   W.L. Gore & Associates, Inc.
   100 Chesapeake Blvd.
   Elkton, MD 21921
   Phone: (410) 392-7600

Attn: NOTIFY LAB IMMEDIATELY UPON DELIVERY!!

<u>IMPORTANT:</u> Samples should <u>not</u> be shipped for weekend or holiday delivery at GORE.

19.1.2 Geoprobe® Grab Sampling using the PRT System

Single event or grab sampling may be conducted using the Post-Run Tubing System (PRT). This system allows EIB personnel to collect soil gas samples quickly and with a high degree of assurance that the samples are representative of the targeted depth, i.e., using this method, there is no leakage at probe rod joints that will compromise the integrity of the sample.

The downhole components of the PRT system include:

- Sample delivery tubing
- Probe rods
- PRT Adapter
- Expendable point holder
- Expendable point

O-ring seals are used on the PRT Adapter and the expendable point holder to provide a leak-proof system that assures sample integrity.

PRT System Installation Procedures

The following procedures are used to collect soil gas samples using the Geoprobe® PRT system. The PRT system can be used with either the 1.0-inch or 1.25-inch diameter probe rod. All parts or accessories used in the PRT system must be selected with the appropriate diameter probe rod in mind to ensure compatibility of all components.

1) Place O-ring on PRT expendable point holder and attach to initial section of probe rod.

2) Place O-ring on expendable point and press into expendable point holder.

3) Add drive cap to probe rod and push PRT system into ground. Add additional probe rods, as needed, to push system to the desired sampling depth.

4) At the desired sampling depth, attach pull cap to probe rod and pull the rod back to disengage the expendable point and expose the soil interval for sampling. Remove the pull cap when this step is completed.

5) Secure the PRT adapter to a length of tubing sufficient to reach from the sampling interval to the surface, with several feet of excess tubing extending beyond the top of the probe rod to facilitate sampling. The adapter is secured tightly to the tubing using electrical tape. This will not compromise the integrity of the sample to be collected, as the sample is pulled directly through the adapter and is never exposed to the tape.

6) Run the tubing and adapter into the probe rod and, using steady downward pressure, turn the tubing counter-clockwise to dock the adapter into the top of the expendable point holder. Tug gently on the tubing to ensure that the adapter docked firmly into the expendable point holder. Failure to dock could indicate that soil intruded during the push or that the expendable point was lost during the push.

7) At this point, the PRT system has been installed and is ready for sampling. If the sample can not be collected immediately, the end of the tubing should be capped.

PRT System Sampling Methodology

Soil gas samples may be collected from the installed PRT system using several methods. These are listed below:

- Cannister Sampling - After purging the PRT system tubing to introduce representative soil gas into the system, an evacuated SUMMA® cannister is attached using a Swagelok® or other suitable secure connection. After connection, the valve on the SUMMA® cannister is opened, pulling soil gas from the exposed soil interval into the cannister.

- Continuous Sampling - Continuous sampling may be conducted using appropriate analytical instrumentation.

Special Considerations for Sampling

The tubing used to complete the PRT system should be Teflon®. As most soil gas sampling will be conducted to investigate the presence or extent of organic compounds, Teflon® tubing is required to ensure the integrity of the sample.

19.1.3 Geoprobe® Permanent Soil Gas Implants

Long-term soil gas sampling may be conducted using permanent soil gas sampling implants installed with the Geoprobe®. Stainless steel implants may be installed at any depth achievable by the Geoprobe® and may be installed in 1.0-inch and 1.25-inch diameter probe rod in custom lengths, using 6-inch (152 mm) or 21-inch (533 mm) screens, which can be connected in any combination. The screens are double-woven stainless steel mesh with 0.0057-inch (0.15 mm) pore openings. A 14-inch long screen is available for use only with the 1.25-inch diameter probe rod.

The following procedures are used by EIB to install a permanent soil gas sampling implant using the Geoprobe®. These are general procedures which are used with either 1.0-inch or 1.25-inch diameter probe rod. Attention should be given to rod diameter when ordering points and point holders.

Installation of Permanent Soil Gas Sampling Implants

1) Attach O-ring to implant point anchor.

2) Press implant point anchor into point holder and attach to first section of probe rod.

3) Push implant point anchor to the desired depth for implant installation.

4) When the desired depth has been reached, attach the implant to the sample delivery tubing. This is accomplished by loosening or removing the Swagelok® fitting and pressing the tubing into the implant. When the end of the tubing is sufficiently engaged in the end of the implant, the Swagelok® fitting is tightened to secure the tubing in the implant. It is critical that the tubing be securely attached to the implant so that it does not pull off during subsequent steps of the installation.

5) Feed the tubing into the probe rod until the implant reaches the implant point anchor. At this point, cut the tubing to allow enough tubing to remain for sampling, usually three to four feet.

6) Rotate the tubing and implant counter-clockwise, threading the implant into the anchor. If there was any soil intrusion during the push, the implant may not dock. If the implant does not dock, it is possible to salvage the installation by removing the implant and sealing the small hole on the bottom of the implant with foil or with a small sheet metal screw then returning the implant to the hole.

7) After the implant has been docked, use a pull cap and pull the probe rod approximately one foot, exposing the implant. Observe the tubing to make sure that anchor remained in place and is not being pulled with the rod.

8) If the implant remained in place, slowly pour a measured amount of 60-100 mesh glass beads down the inside of the probe rod. The glass beads are used as a filter pack around the implant. Ideally, the implant should be covered with beads with approximately six inches of beads above the top of the implant. The volume of beads should be calculated based on the length of implant used. While pouring the beads, it is advisable to gently shake the tubing to prevent the beads from bridging inside the probe rod.

9) After placing the beads, the implant is sealed using a flowable mixture of the glass beads and fine-powdered bentonite. To accomplish this, two to three feet of rod is pulled and the mixture is slowly poured into the rod above the bead-packed implant. As with the bead placement, similar care should be taken to avoid bridging of this mixture.

10) If it is appropriate to grout the installation, grouting may be accomplished either through pressure grouting through the probe rod as the rods are pulled after placement of the seal or, if the hole remains open, the grout may be mixed and poured down the open hole after retrieval of the rods.

11) For permanent or long-term installations, efforts should be taken to protect the tubing at the surface using some type of surface completion and protective casing.

Permanent Soil Gas Sampling Methodology

Soil gas samples may be collected from the installed permanent soil gas implant using several methods. These are listed below:

- Cannister Sampling - After purging implant tubing to introduce representative soil gas into the system, an evacuated SUMMA® cannister is attached using a Swagelok® or other suitable secure connection. After connection, the valve on the SUMMA® cannister is opened, pulling soil gas from the implant into the cannister.

- Continuous Sampling - Continuous sampling may be conducted using appropriate analytical instrumentation.

Special Considerations for Sampling

The tubing used for the permanent soil gas implant should be Teflon®. As most soil gas sampling will be conducted to investigate the presence or extent of organic compounds, Teflon® tubing is required to ensure the integrity of the sample.

19.2 References

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2. GORE-SORBER® Screening Survey Module Storage, Installation, and Retrieval Information, W.L. Gore & Associates, Inc., Elkton, MD.

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APPENDIX A
RECOMMENDED VOLUMES, CONTAINER TYPES, PRESERVATION and HOLDING TIMES

The following tables summarize the amount of sample required, typical containers, preservative (if any) and holding times for many analyses, by media.

Soil and Sediment - Organic Compounds				
Analysis	Amt.[1]	Container Type[2]	Preservative[3]	Holding Time[4]
Dioxin/Dibenzofurans	8 oz.	G	ice	30
Extractable Organic Compounds/pesticides/ PCBs	8 oz.	G	ice	14
Extractable Organic Compounds - TCLP	8 oz.	G	ice	14
Organic Halide	8 oz.	G	ice	28
VOC $\leq$ 200 ug\kg (water suspension)	120 ml.	G/S	ice	48 Hours
VOC $\leq$ 200 ug\kg	15 g.	E	ice	48 Hours
VOC $\leq$ 200 ug\kg (water suspension)	120 ml.	G/S	$NaHSO_4$ (pH<2), ice	14
VOC $\geq$ 200 ug\kg	120 ml.	G/S	CH_3OH, ice	14
VOC $\geq$ 200 ug\kg	15 g.	E	ice	48 Hours
VOC $\geq$ 200 ug\kg	2 oz.	G/S	ice	48 Hours
VOC - TCLP Analysis	2 oz.	G	ice	14

Soil and Sediment - Inorganic Compounds				
Analysis	Amt.[1]	Container Type[2]	Preservative[3]	Holding Time[4]
Chloride	8 oz.	G	NA	NS
Chromium - hexavalent	8 oz.	G	ice	30
Cyanide	8 oz.	G	ice	NS
COD	8 oz.	G	ice	NS
Fluoride	8 oz.	G	NA	NS
Grain size	8 oz.	G	NA	NS
Mercury	8 oz.	G	ice	28
Mercury - TCLP	8 oz.	G	NA	28
Metals	8 oz.	G	ice	180
Metals - TCLP	8 oz.	G	NA	180
Metals - EP	8 oz.	G	NA	180
Nitrate	8 oz.	G	ice	NS
Nitrite	8 oz.	G	ice	NS
Nutrients (ammonia, TKN, NO2, NO3, N, total phosphate)	8 oz.	G	ice	NS
pH	8 oz.	G	NA	NS
Sulfates	8 oz.	G	NA	NS
Sulfides	8 oz.	G	ice	NS
TOC	8 oz.	G	ice	NS

Water and Waste Water - Biological				
Analysis	Amt.[1]	Container Type[2]	Preservative[3]	Holding Time[4]
Bacteriological	150 ml.	P, G, W	ice	6 Hours
Toxicity, acute	1 gal.	C	ice	36 Hours
Toxicity, chronic	1 gal.	C	ice	36 Hours

Water and Waste Water - Organic Compounds				
Analysis	Amt.[1]	Container Type[2]	Preservative[3]	Holding Time[4]
Alcohol - Percent	1gal.	G/A	ice	NS
Dioxin/Dibenzofurans	2 L.	L/A	ice (0°- 4° C.)	365
Dioxin/Dibenzofurans - residual chlorine	2 L.	L/A	ice (0°- 4° C.) 80 mg. sodium thiosulfate /L.	365
Methane/Ethane/Ethene	120 ml.	G/S	HCl (pH<2), ice	14
Extractable Organic Compounds/ pesticides/ PCBs	1 gal.	G/A	ice	7
Extractable Organic Compounds/ pesticides/PCBs - residual chlorine present	1 gal.	G/A	3 ml. of 10% sodium thiosulfate per gallon	7
Extractable Organic Compounds - TCLP	1 gal.	G/A	ice	14
Organic Halide	1 L.	G/A	H_2SO_4 (pH<2), ice	28
Phenols	1 L.	G/A	H_2SO_4 (pH<2), ice	28
Volatile Organic Compounds	120 ml.	G/S	ice	7
Volatile Organic Compounds	120 ml.	G/S	HCl (pH<2), ice	14
Volatile Organic Compounds	120 ml.	G/S	$NaHSO_4$ (pH<2), ice	14
Volatile Organic Compounds - residual chlorine present	120 ml.	G/S	HCl (pH<2), ice[5]	14
Volatile Organic compounds - TCLP	120 ml.	G/S	ice	14

Water and Waste Water - Inorganic Compounds				
Analysis	Amt.[1]	Container Type[2]	Preservative[3]	Holding Time[4]
Ammonia	1 L.	P	H_2SO_4 (pH<2), ice	28
Alkalinity	1 L.	P	ice	14
BOD5	2 L.	P	ice	2
Bromide	1 L.	P	ice	28
Chlorine - Residual	500 ml.	P	NA	ASAP
Chloride	1 L.	P	NA	28
Chromium - hexavalent	1 L.	P	ice	24 Hours
COD	1 L.	P	H_2SO_4 (pH<2), ice	28
Color	1 gal.	G/A	ice	2
Conductivity	500 ml.	P	ice	28
Cyanide	1 L.	P	NaOH (pH>12)	14
Cyanide - Residual chlorine	1 L.	P	see footnote 6	14
DOC	1 L.	P	H_2SO4 (pH<2), ice	28
Fluoride	1 L.	P	NA	28
Hardness	1 L.	P	HNO_3 (pH<2)	180
Iron (Fe^{2+})	1 L.	P	NA	ASAP
Mercury	1 L.	P	HNO_3 (pH<2)	28
Mercury - TCLP	1 L.	P	NA	28
Metals	1 L.	P	HNO_3 (pH<2)	180
Metals - TCLP	1 L.	P	NA	180
Metals - EP	1 L.	P	NA	180
Nitrate	2 L.	P	ice	2
Nitrite	1 L.	P	ice	2
Nutrients (Ammonia, TKN, NO2, NO3, -N, total phosphorus)	2 L.	P	H_2SO_4 (pH<2), ice	28

Water and Waste Water - Inorganic Compounds (continued)				
Analysis	Amt.[1]	Container Type[2]	Preservative[3]	Holding Time[4]
Oil and Grease	1 L.	P	H_2SO_4 (pH<2), ice	28
Oxygen - dissolved	40 ml.	G	NA	ASAP
pH	500 ml.	P	NA	ASAP
Phenols	1 L.	P	H_2SO_4 (pH<2), ice	28
Phosphate - ortho	1 L.	P	ice	2
Phosphate - dissolved	1 L.	P	H_2SO_4 (pH<2), ice	28
Solids Series	2 L.	P	ice	7
Solids - Settleable	2 L.	P	ice	2
Sulfates	1 L.	P	ice	28
Sulfides	1 L.	P	2 ml zinc acetate, NaOH (pH>9), ice	7
Temperature	500 ml.	P	none	ASAP
TOC	1 L.	P	H_2SO_4 (pH<2), ice	NS
Turbidity	500 ml.	P	ice	2

Waste - Organic Compounds				
Analysis	Amt.[1]	Container Type[2]	Preservative[3]	Holding Time[4]
Alcohol - Percent	8 oz.	G	NA	NS
Dioxin/Dibenzofurans	8 oz.	G	ice	75
Extractable Organic Compounds/pesticides/ PCBs	8 oz.	G	NA	14
Extractable Organic Compounds - TCLP	8 oz.	G	NA	14
VOC $\leq$ 200 ug\kg	2 oz.	G	ice	48 hours
VOC $\leq$ 200 ug\kg	15 g.	E	ice	48 hours
VOC $\geq$ 200 ug\kg	8 oz.	G	NA	48 hours
Volatile Organic compounds - TCLP	8 oz.	G	NA	28
Waste - Inorganic Compounds				
Analysis	Amt.[1]	Container Type[2]	Preservative[3]	Holding Time[4]
Ash Content	8 oz.	G	NA	NS
BTU Content	8 oz.	G	NA	NS
Chromium - hexavalent	8 oz.	G	NA	NS
Cyanide	8 oz.	G	NA	NS
Dermal Corrosion	8 oz.	G	NA	NS
Flashpoint	8 oz.	G	NA	NS
Mercury	8 oz.	G	NA	180
Mercury - TCLP	8 oz.	G	NA	NS
Metals	8 oz.	G	NA	28
Metals - TCLP	8 oz.	G	NA	NS
Metals - EP	8 oz.	G	NA	28
pH	8 oz.	G	NA	NS
Sulfides	8 oz.	G	NA	NS

Footnotes:

1. Amount - The amounts listed must be considered approximate requirements that are appropriate for most media. If a particular media to be sampled is very light, more sample may be required to obtain the necessary mass for the analysis.

2. Container Type:

   G = Glass
   P = Polyethylene
   E = Encore™
   C = Cubitainer
   S = Septum Seal
   A = Amber
   W = Whirl-Pak™

3. ice: Sufficient ice must be placed in the shipping/transport container to ensure that ice is still present when the samples are received at the laboratory

   $NaHSO_4$: The proper amount of $NaHSO_4$ (Sodium Bisulfate) is added to the sample container at the laboratory prior to sampling.

   CH_3OH: The proper amount of CH_3OH (Methanol) is added to the sample container at the laboratory prior to sampling.

   HCl: HCl (Hydrochloric Acid) used as a preservative must be present at concentrations of 0.04% or less by weight (pH about 1.96 or greater), as specified in 40 CFR 136.3, Table II, footnote 3. The proper amount of HCl is added to the sample container at the laboratory prior to sampling.

   H_2SO_4: H_2SO_4 (Sulfuric Acid) used as a preservative must be present at concentrations of 0.35% or less by weight (pH about 1.15 or greater), as specified in 40 CFR 136.3, Table II, footnote 3. Approximately 5 ml. of the laboratory prepared preservative is added to the sample.

   NaOH: NaOH (Sodium Hydroxide) used as a preservative must be present at concentrations of 0.080% or less by weight (pH about 12.30 or less), as specified in 40 CFR 136.3, Table II, footnote 3. Four tablets are added to the sample after collection.

   HNO_3: HNO_3 (Nitric Acid) used as a preservative must be present at concentrations of 0.15% or less by weight (pH about 1.62 or greater), as specified in 40 CFR 136.3, Table II, footnote 3. Approximately 5 ml. of the laboratory prepared preservative is added to the sample.

   NA: Not Applicable. No sample preservation is required

4. Holding Time - Holding time is stated in days unless marked otherwise. A holding time of ASAP indicates the sample is to be analyzed within 15 minutes. A holding time of NS indicates that no holding time is specified in the analytical method.

5. Collect sample in 8 oz. glass container containing ascorbic acid solution prepared by the laboratory. Gently mix sample and transfer to sample containers prepared by the laboratory with the proper amount of HCl.

6. Use ascorbic acid only if the sample contains residual chlorine. To test for residual chlorine, place a drop of sample on potassium iodide-starch test paper. If the test paper turns blue, residual chlorine is present. Add a few crystals of ascorbic acid and re-test until the test paper no longer turns blue. Add an additional 0.6 gram of ascorbic acid for each liter of sample.

APPENDIX B
STANDARD FIELD CLEANING PROCEDURES

PERFORMANCE OBJECTIVE:

- To remove contaminants of concern from sampling, drilling and other field equipment to concentrations that do not impact study objectives using a standard cleaning procedure.

B.1 Introduction

Cleaning procedures in this appendix are intended for use by field personnel for cleaning sampling and other equipment in the field. Emergency field sample container cleaning procedures are also included; however, they should not be used unless absolutely necessary. Cleaning procedures for use at the Field Equipment Center (FEC) are in Appendix C.

Sampling and field equipment cleaned in accordance with these procedures must meet the minimum requirements for Data Quality Objectives (DQO) definitive data collection. Deviations from these procedures should be documented in the approved study plan, field records, and investigative reports.

These are the materials, methods, and procedures to be used when cleaning sampling and other equipment in the field.

B.1.1 Specifications for Cleaning Materials

Specifications for standard cleaning materials referred to in this appendix are as follows:

- Soap shall be a standard brand of phosphate-free laboratory detergent such as Liquinox®. Use of other detergent must be justified and documented in the field logbooks and inspection or investigative reports.

- Solvent shall be pesticide-grade isopropanol. Use of a solvent other than pesticide-grade isopropanol for equipment cleaning purposes must be justified in the study plan. Otherwise its use must be documented in field logbooks and inspection or investigation reports.

- Tap water may be used from any municipal water treatment system. Use of an untreated potable water supply is not an acceptable substitute for tap water.

- Analyte free water (deionized water) is tap water that has been treated by passing through a standard deionizing resin column. At a minimum, the finished water should contain no detectable heavy metals or other inorganic compounds (i.e., at or above analytical detection limits) as defined by a standard inductively coupled Argon Plasma Spectrophotometer (ICP) (or equivalent) scan. Analyte free water obtained by other methods is acceptable, as long as it meets the above analytical criteria.

- Organic/analyte free water is defined as tap water that has been treated with activated carbon and deionizing units. A portable system to produce organic/analyte free water under field conditions is available. At a minimum, the finished water must meet the analytical criteria of analyte free water and should contain no detectable pesticides, herbicides, or extractable organic compounds, and no volatile organic compounds above minimum detectable levels as determined by the Region 4 laboratory for a given set of analyses. Organic/analyte free water obtained by other methods is acceptable, as long as it meets the above analytical criteria.

- Other solvents may be substituted for a particular purpose if required. For example, removal of concentrated waste materials may require the use of either pesticide-grade hexane or petroleum ether. After the waste material is removed, the equipment must be subjected to the standard cleaning procedure. Because these solvents are not miscible with water, the equipment must be completely dry prior to use.

Solvents, laboratory detergent, and rinse waters used to clean equipment shall not be reused during field decontamination.

B.1.2 Handling and Containers for Cleaning Solutions

Improperly handled cleaning solutions may easily become contaminated. Storage and application containers must be constructed of the proper materials to ensure their integrity. Following are acceptable materials used for containing the specified cleaning solutions:

- Soap must be kept in clean plastic, metal, or glass containers until used. It should be poured directly from the container during use.

- Solvent must be stored in the unopened original containers until used. They may be applied using the low pressure nitrogen system fitted with a Teflon® nozzle, or using Teflon® squeeze bottles.

- Tap water may be kept in clean tanks, hand pressure sprayers, squeeze bottles, or applied directly from a hose.

- Analyte free water must be stored in clean glass, stainless steel, or plastic containers that can be closed prior to use. It can be applied from plastic squeeze bottles.

- Organic/analyte free water must be stored in clean glass, Teflon®, or stainless steel containers prior to use. It may be applied using Teflon® squeeze bottles, or with the portable system.

Note: Hand pump sprayers generally are not acceptable storage or application containers for the above materials (with the exception of tap water). This also applies to stainless steel sprayers. All hand sprayers have internal oil coated gaskets and black rubber seals that may contaminate the solutions.

B.1.3 Disposal of Solvent Cleaning Solutions

Procedures for the safe handling and disposition of investigation derived waste (IDW), including used wash water, rinse water, and spent solvents are in Section 5.15.

B.1.4 Equipment Contaminated with Concentrated Wastes

Equipment used to collect samples of hazardous materials or toxic wastes or materials from hazardous waste sites, RCRA facilities, or in-process waste streams should be field cleaned before returning from the study. At a minimum, this should consist of washing with soap and rinsing with tap water. More stringent procedures may be required at the discretion of the field investigators.

B.1.5 Safety Procedures for Field Cleaning Operations

Some of the materials used to implement the cleaning procedures outlined in this appendix can be harmful if used improperly. Caution should be exercised by all field investigators and all applicable safety procedures should be followed. At a minimum, the following precautions should be taken in the field during these cleaning operations:

- Safety glasses with splash shields or goggles, and latex gloves will be worn during all cleaning operations.
- Solvent rinsing operations will be conducted in the open (never in a closed room).
- No eating, smoking, drinking, chewing, or any hand to mouth contact should be permitted during cleaning operations.

B.1.6 Handling of Cleaned Equipment

After field cleaning, equipment should be handled only by personnel wearing clean gloves to prevent re-contamination. In addition, the equipment should be moved away (preferably upwind) from the cleaning area to prevent recontamination. If the equipment is not to be immediately re-used it should be covered with plastic sheeting or wrapped in aluminum foil to prevent re-contamination. The area where the equipment is kept prior to re-use must be free of contaminants.

B.2 Field Equipment Cleaning Procedures

Sufficient clean equipment should be transported to the field so that an entire study can be conducted without the need for field cleaning. However, this is not possible for some specialized items such as portable power augers (Little Beaver®), well drilling rigs, soil coring rigs, and other large pieces of field equipment. In addition, particularly during large scale studies, it is not practical or possible to transport all of the precleaned field equipment required into the field. In these instances, sufficient pre-cleaned equipment should be transported to the field to perform at least one days work. The following procedures are to be utilized when equipment must be cleaned in the field.

B.2.1 Specifications for Decontamination Pads

Decontamination pads constructed for field cleaning of sampling and drilling equipment should meet the following minimum specifications:

- The pad should be constructed in an area known or believed to be free of surface contamination.
- The pad should not leak excessively.
- If possible, the pad should be constructed on a level, paved surface and should facilitate the removal of wastewater. This may be accomplished by either constructing the pad with one corner lower than the rest, or by creating a sump or pit in one corner or along one side. Any sump or pit should also be lined.
- Sawhorses or racks constructed to hold equipment while being cleaned should be high enough above ground to prevent equipment from being splashed.
- Water should be removed from the decontamination pad frequently.

- A temporary pad should be lined with a water impermeable material with no seams within the pad. This material should be either easily replaced (disposable) or repairable.

At the completion of site activities, the decontamination pad should be deactivated. The pit or sump should be backfilled with the appropriate material designated by the site project leader, but only after all waste/rinse water has been pumped into containers for disposal. No solvent rinsates will be placed in the pit. Solvent rinsates should be collected in separate containers for proper disposal. See Section 5.15 of this SOP for proper handling and disposal of these materials. If the decontamination pad has leaked excessively, soil sampling may be required.

B.2.2 "Classic Parameter" Sampling Equipment

"Classic Parameters" are analyses such as oxygen demand, nutrients, certain inorganics, sulfide, flow measurements, etc. For routine operations involving classic parameter analyses, water quality sampling equipment such as Kemmerers, buckets, dissolved oxygen dunkers, dredges, etc., may be cleaned with the sample or analyte-free water between sampling locations. A brush may be used to remove deposits of material or sediment, if necessary. If analyte-free water is unavailable the samplers should be flushed at the next sampling location with the substance (water) to be sampled, before the sample is collected.

Flow measuring equipment such as weirs, staff gages, velocity meters, and other stream gaging equipment may be cleaned with tap water between measuring locations, if necessary.

The previously described procedures are not to be used for cleaning field equipment to be used for the collection of samples undergoing trace organic or inorganic constituent analyses.

B.2.3 Sampling Equipment used for the Collection of Trace Organic and Inorganic Compounds

The following procedures are to be used for all sampling equipment used to collect routine samples undergoing trace organic or inorganic constituent analyses:

1. Clean with tap water and soap using a brush if necessary to remove particulate matter and surface films. Equipment may be steam cleaned (soap and high pressure hot water) as an alternative to brushing. Sampling equipment that is steam cleaned should be placed on racks or saw horses at least two feet above the floor of the decontamination pad. PVC or plastic items should not be steam cleaned.

2. Rinse thoroughly with tap water.

3. Rinse thoroughly with analyte free water.

4. Rinse thoroughly with solvent. Do not solvent rinse PVC or plastic items.

5. Rinse thoroughly with organic/analyte free water. If organic/analyte free water is not available, equipment should be allowed to completely dry. Do not apply a final rinse with analyte water. Organic/analyte free water can be generated on-site utilizing the portable system.

6. Remove the equipment from the decontamination area and cover with plastic. Equipment stored overnight should be wrapped in aluminum foil and covered with clean, unused plastic.

B.2.4 Well Sounders or Tapes

1. Wash with soap and tap water.

2. Rinse with tap water.

3. Rinse with analyte free water.

B.2.5 Goulds® Pump Cleaning Procedure

CAUTION - During cleaning always disconnect the pump from the generator.

The Goulds© pump should be cleaned prior to use and between each monitoring well. The following procedure is required:

1. Using a brush, scrub the exterior of the contaminated hose and pump with soap and tap water.

2. Rinse the soap from the outside of the pump and hose with tap water.

3. Rinse the tap water residue from the outside of pump and hose with analyte-free water.

4. Place the pump and hose in a clean plastic bag.

B.2.6 Redi-Flo2® Pump

The Redi-Flo2® pump should be cleaned prior to use and between each monitoring well. The following procedure is required:

CAUTION - Make sure the pump is not plugged in.

1. Using a brush, scrub the exterior of the pump, electrical cord and garden hose with soap and tap water. Do not wet the electrical plug.

2. Rinse with tap water.

3. Rinse with analyte free water.

4. Place the equipment in a clean plastic bag.

To clean the Redi-Flo2® ball check valve:

1. Completely dismantle ball check valve. Check for wear and/or corrosion, and replace as needed.

2. Using a brush, scrub all components with soap and tap water.

3. Rinse with analyte free water.

4. Reassemble and re-attach the ball check valve to the Redi-Flo2® pump head.

B.2.7 Automatic Sampler Tubing

The Silastic® and Tygon® tubing previously used in the automatic samplers may be field cleaned as follows:

1. Flush tubing with tap water and soap.

2. Rinse tubing thoroughly with tap water.

3. Rinse tubing with analyte free water.

B.3 Downhole Drilling Equipment

These procedures are to be used for drilling activities involving the collection of soil samples for trace organic and inorganic constituent analyses, and for the construction of monitoring wells to be used for the collection of groundwater samples for trace organic and inorganic constituent analyses.

B.3.1 Introduction

Cleaning and decontamination of all equipment should occur at a designated area (decontamination pad) on the site. The decontamination pad should meet the specifications of Section B.2.1.

Tap water (potable) brought on the site for drilling and cleaning purposes should be contained in a pre-cleaned tank.

A steam cleaner and/or high pressure hot water washer capable of generating a pressure of at least 2500 PSI and producing hot water and/or steam (200°F plus), with a soap compartment, should be obtained.

B.3.2 Preliminary Cleaning and Inspection

The drill rig should be clean of any contaminants that may have been transported from another hazardous waste site, to minimize the potential for cross-contamination. Further, the drill rig itself should not serve as a source of contaminants. In addition, associated drilling and decontamination equipment, well construction materials, and equipment handling procedures should meet these minimum specified criteria:

- All downhole augering, drilling, and sampling equipment should be sandblasted before use if painted, and/or there is a buildup of rust, hard or caked matter, etc., that cannot be removed by steam cleaning (soap and high pressure hot water), or wire brushing. Sandblasting should be performed <u>prior to arrival</u> on site, or well away from the decontamination pad and areas to be sampled.

- Any portion of the drill rig, backhoe, etc., that is over the borehole (kelly bar or mast, backhoe buckets, drilling platform, hoist or chain pulldowns, spindles, cathead, etc.) should be steam cleaned (soap and high pressure hot water) and wire brushed (as needed) to remove all rust, soil, and other material which may have come from other hazardous waste sites before being brought on site.

- Printing and/or writing on well casing, tremie tubing, etc., should be removed before use. Emery cloth or sand paper can be used to remove the printing and/or writing. Most well material suppliers can supply materials without the printing and/or writing if specified when ordered.

- The drill rig and other equipment associated with the drilling and sampling activities should be inspected to insure that all oils, greases, hydraulic fluids, etc., have been removed, and all seals and gaskets are intact with no fluid leaks.

- PVC or plastic materials such as tremie tubes should be inspected. Items that cannot be cleaned are not acceptable and should be discarded.

B.3.3 Drill Rig Field Cleaning Procedure

Any portion of the drill rig, backhoe, etc., that is over the borehole (kelly bar or mast, backhoe buckets, drilling platform, hoist or chain pulldowns, spindles, cathead, etc.) should be steam cleaned (soap and high pressure hot water) between boreholes.

B.3.4 Field Cleaning Procedure for Drilling Equipment

The following is the standard procedure for field cleaning augers, drill stems, rods, tools, and associated equipment. This procedure does <u>not</u> apply to well casings, well screens, or split-spoon samplers used to obtain samples for chemical analyses, which should be cleaned as outlined in Section B.2.3.

1. Clean with tap water and soap, using a brush if necessary, to remove particulate matter and surface films. Steam cleaning (high pressure hot water with soap) may be necessary to remove matter that is difficult to remove with the brush. Drilling equipment that is steam cleaned should be placed on racks or saw horses at least two feet above the floor of the decontamination pad. Hollow-stem augers, drill rods, etc., that are hollow or have holes that transmit water or drilling fluids, should be cleaned on the inside with vigorous brushing.

2. Rinse thoroughly with tap water.

3. Remove from the decontamination pad and cover with clean, unused plastic. If stored overnight, the plastic should be secured to ensure that it stays in place.

When there is concern for low level contaminants it may be necessary to clean this equipment between borehole drilling and/or monitoring well installation using the procedure outlined in Section B.2.3.

B.4 Emergency Disposable Sample Container Cleaning

New one-pint or one-quart mason jars may be used to collect samples for analyses of organic compounds and metals in waste and soil samples during an emergency. These containers would also be acceptable on an emergency basis for the collection of water samples for extractable organic compounds, pesticides, and metals analyses. These jars cannot be used for the collection of water samples for volatile organic compound analyses.

The rubber sealing ring should not be in contact with the jar and aluminum foil should be used, if possible, between the jar and the sealing ring. If possible, the jar and aluminum foil should be rinsed with pesticide-grade isopropanol and allowed to air dry before use. Several empty bottles and lids should be submitted to the laboratory as blanks for quality control purposes.

APPENDIX C
FIELD EQUIPMENT CENTER STANDARD CLEANING PROCEDURES

PERFORMANCE OBJECTIVE:

- To remove contaminants of concern from sampling, drilling and other field equipment to concentrations that do not impact study objectives using a standard cleaning procedure.

C.1 Introduction

Cleaning procedures outlined in this appendix are intended for use at the Field Equipment Center (FEC) for cleaning sampling and other field equipment prior to field use. These procedures are not intended to be used in the field. Cleaning procedures for use in the field are in Appendix B.

Sampling and other field equipment cleaned in accordance with these procedures will meet the minimum requirements for Data Quality Objective (DQO) Definitive Data Collection. Deviations from these procedures should be documented in the approved study plan, field records, and investigative reports.

C.1.1 Specifications For Cleaning Materials

The specifications for standard cleaning materials referred to in this appendix are as follows:

- <u>Soap</u> shall be a standard brand of phosphate-free laboratory detergent such as Liquinox®.
- <u>Disinfectant soap</u> shall be a standard brand of disinfectant cleaner.
- <u>Solvent</u> shall be pesticide grade isopropanol.
- <u>Tap water</u> may be obtained from any spigot at the FEC.
- <u>Nitric acid solution</u> (10%) shall be made from reagent-grade nitric acid and deionized water.
- <u>Analyte free water (deionized water)</u> is tap water that has been treated by passing it through a standard deionizing resin column. At a minimum, it should contain no detectable heavy metals or other inorganic compounds (i.e., at or above analytical detection limits) as defined by a standard Inductively Coupled Argon Plasma Spectrophotometer (ICP) (or equivalent) scan.
- <u>Organic/analyte free water</u> is defined as tap water that has been treated with activated carbon and deionizing units. At a minimum, it must meet the analytical criteria of analyte free water and should contain no detectable pesticides, herbicides, or extractable organic compounds, and no volatile organic compounds above minimum detectable levels determined by the Region 4 laboratory for a given set of analyses. Organic/analyte free water obtained by other methods is acceptable, as long as it meets the above analytical criteria.

- Other solvents may be substituted for a particular investigation if needed. Pesticide-grade acetone or methanol are acceptable. However, it should be noted that if pesticide-grade acetone is used, the detection of acetone in samples collected with acetone rinsed equipment is considered suspect. Pesticide-grade methanol is much more hazardous to use than either pesticide-grade acetone or isopropanol, therefore its use is discouraged.

Solvents, nitric acid solution, laboratory detergent, and rinse waters used to clean equipment cannot be reused.

C.1.2 Handling and Containers for Cleaning Solutions

Improperly handled cleaning solutions may easily become contaminated. Containers should be constructed of the proper materials to ensure their integrity. Following are the materials to be used for storing the specified cleaning materials:

- Soap should be kept in clean containers until use. It should be poured directly from the container.

- Disinfectant soap should be kept in clean containers until use. It should be poured directly from the container.

- Solvents should be stored in the unopened original containers until used. Solvents may be applied using the low pressure nitrogen system fitted with a Teflon® nozzle, or by using Teflon® squeeze bottles.

- Tap water may be kept in clean tanks, hand pressure sprayers, squeeze bottles, or applied directly from a hose.

- Analyte free water should be stored in cleaned containers that can be closed when not being used. It may be applied from squeeze bottles.

- Organic/analyte free water should be stored in cleaned glass, Teflon®, or stainless steel containers prior to use. It may be applied using Teflon® squeeze bottles, or directly from the system.

- Nitric acid should be kept in the glass container it is received in, and placed in squeeze bottles prior to application.

C.1.3 Disposal of Spent Cleaning Solutions

Procedures for safe handling and disposition of spent cleaning solutions, including washwater, rinse water, spent acid solutions, and spent solvents are as follows:

Washwater

Since equipment is decontaminated before its return to the FEC, the washwater may be disposed in the sanitary drain in the washroom. When large equipment (vehicles, augers, etc.) is washed outside, it may wash onto the ground without recovery of the washwater.

Rinsewater

Since equipment is decontaminated before its return to the FEC, the rinsewater may be disposed in the sanitary drain in the washroom. When large equipment (vehicles, augers, etc.) is rinsed outside, it may go onto the ground without recovery.

Nitric Acid

Nitric acid cleaning solutions are to be diluted to a pH greater than 2.0, and flushed down the sanitary drain in the washroom. If used outdoors, this material should be captured and diluted to a pH greater than 2.0, and flushed down the sanitary drain in the washroom.

Solvent

All solvents used should be captured, properly labeled, and stored on the premises of the FEC until arrangements for proper disposal are made. Used solvents can be classified as either "solvent for recovery" or "solvent for disposal". Solvent for recovery is that which was used in the standard field cleaning or FEC cleaning of equipment. Solvent used for cleaning badly contaminated equipment (e.g., tar removal, etc.) should be designated for disposal. The two groups should be labeled "For Recovery" or "For Disposal" and stored separately at the FEC.

C.1.4 Safety Procedures for Cleaning Operations

Some materials used to implement the cleaning procedures outlined in this Appendix are harmful if used improperly. Caution should be exercised and all applicable safety procedures shall be followed. At a minimum, the following precautions shall be taken in the washroom during these cleaning operations:

- Safety glasses with splash shields or goggles, a neoprene apron, and neoprene gloves will be worn during all cleaning operations. When cleaning heavy items such as hollow-stem augers or other drill rig equipment, safety boots will be worn.

- All solvent rinsing operations will be conducted under a fume hood or in the open (never in a closed room).

- No eating, smoking, drinking, chewing, or any hand to mouth contact shall be permitted during cleaning operations.

C.1.5 Handling and Labeling of Cleaned Equipment

After cleaning, equipment should be handled only by personnel wearing clean latex gloves to prevent re-contamination.

After the cleaned equipment is wrapped in aluminum foil and sealed in plastic, the date that the equipment was cleaned should be written on the plastic. If the equipment was not cleaned according to the procedures outlined in this appendix, this should also be noted on the plastic.

C.1.6 Initial Processing of Returned Equipment

Field or sampling equipment that needs to be repaired will be identified with a "repair" tag. Any problems encountered with the equipment and specific required repairs shall be noted on this tag, as well as the date and the initials of the investigator. Field equipment or reusable sample containers needing cleaning or repairs will not be stored with clean equipment, sample tubing, or sample containers.

All coolers, plastic wrapped equipment, containers, and tubing not used in the field may be placed back into stock after the following precautions are taken:

- Soap and hot water rinse plastic containers. Allow to air dry.
- If plastic wrapping leaks after soap/water rinse, remove the equipment and place it into the standard cleaning process.

C.2 Trace Organic and Inorganic Constituent Sampling Equipment

Sampling equipment used to collect samples undergoing trace organic and/or inorganic constituent analyses should be thoroughly cleaned. The following procedures are to be used.

C.2.1 Teflon® and Glass

1. Wash equipment thoroughly with soap and hot tap water using a brush or scrub pad to remove any particulate matter or surface film.
2. Rinse equipment thoroughly with hot tap water.
3. Rinse equipment with 10 percent nitric acid solution. Small and awkward equipment such as vacuum bottle inserts and well bailer ends may be soaked in the nitric acid solution instead of being rinsed with it. Fresh nitric acid solution should be prepared for each cleaning session.
4. Rinse equipment thoroughly with analyte free water.
5. Rinse equipment thoroughly with solvent and allow to air dry for at least 24 hours.
6. Wrap equipment in one layer of aluminum foil. Roll edges of foil into a "tab" to allow for easy removal. Seal the foil wrapped equipment in plastic and label.

When this sampling equipment is used to collect samples that contain oil, grease, or other hard to remove materials, it may be necessary to rinse the equipment several times with pesticide-grade acetone, hexane, or petroleum ether to remove the materials before proceeding with the first step. In extreme cases, it may be necessary to steam clean the field equipment before proceeding with Step 1. If the equipment cannot be cleaned utilizing these procedures, it should be discarded.

C.2.2 Stainless Steel or Steel

1. Wash equipment thoroughly with soap and hot tap water using a brush or scrub pad to remove any particulate matter or surface film.

2. Rinse equipment thoroughly with hot tap water.

3. Rinse equipment thoroughly with analyte free water.

4. Rinse equipment thoroughly with solvent and allow to air dry for at least 24 hours.

5. Wrap equipment in one layer of aluminum foil. Roll edges of foil into a "tab" to allow for easy removal. Seal the foil wrapped equipment in plastic and label.

When this sampling equipment is used to collect samples that contain oil, grease, or other hard to remove materials, it may be necessary to rinse the equipment several times with pesticide-grade acetone, hexane, or petroleum ether to remove the materials before proceeding with the first step. In extreme cases, it may be necessary to steam clean the field equipment before proceeding with Step 1. If the equipment cannot be cleaned utilizing these procedures, it should be discarded.

C.2.3 Reusable Composite Sample and Organic/Analyte Free Water Containers *

These containers will be rinsed with organic/analyte free water and the rinse water will be submitted to the Region 4 laboratory. This activity may be conducted in the event of a special, civil or criminal investigation.

C.3 Automatic Wastewater Sampling Equipment

C.3.1 ISCO© and Other Automatic Samplers

- The exterior and accessible interior (excluding the waterproof timing mechanism) portions of the automatic samplers will be washed with soap and tap water then rinsed with tap water.

- Desiccant in the flow meters should be checked and replaced, if necessary, each time the equipment is cleaned.

- The face of the timing case mechanism will be cleaned with a clean damp cloth.

- Tubing (sample intake and pump tubing) will be discarded after each use.

- New pre-cleaned, Silastic pump tubing (see Appendix C.4.1) will be installed.

C.3.2 ISCO© 1680, 2700, and 3700 Rotary Funnel, Distributor, and Metal Tube

1. Clean with hot tap water, soap, and a brush.

2. Rinse thoroughly with analyte free water.

3. Replace in sampler.

C.3.3 All Automatic Sampler Headers

1. Disassemble header and using a bottle brush, wash with hot tap water and soap.

2. Rinse thoroughly with analyte free water.

3. Dry thoroughly, then reassemble header and wrap with aluminum foil.

4. Seal in Plastic

C.3.4 Reusable Glass Composite Sample Containers

1. Wash containers thoroughly with hot tap water and laboratory detergent, using a bottle brush to remove particulate matter and surface film.

2. Rinse containers thoroughly with hot tap water.

3. Rinse containers with at least 10 percent nitric acid.

4. Rinse containers thoroughly with tap water.

5. Rinse containers thoroughly with analyte free water.

6. Rinse twice with solvent and allow to air dry for at least 24 hours.

7. Cap with aluminum foil or Teflon® film.

When these containers are used to collect samples that contain oil, grease, or other hard to remove materials, it may be necessary to rinse the containers several times with pesticide-grade acetone, hexane, or petroleum ether to remove the materials before proceeding with Step 1. Any bottles that have a visible film, scale, or discoloration remaining after this cleaning procedure shall also be discarded.

C.3.5 Plastic Reusable Composite Sample Containers (2700 - 5 gal., 3700 - 4 gal.)

1. Wash containers thoroughly with hot tap water and laboratory detergent, using a bottle brush to remove particulate matter and surface film.

2. Rinse containers thoroughly with hot tap water.

3. Rinse containers with at least 10 percent nitric acid.

4. Rinse containers thoroughly with tap water.

5. Rinse containers thoroughly with analyte free water.

6. Cap with aluminum foil or Teflon® film.

Any plastic composite sample containers that have a visible film, scale, or other discoloration remaining after this cleaning procedure will be discarded.

C.3.6 ISCO© 1680, 2700, and 3700 Glass Sequential Bottles for GC/MS Analyses

1. Rinse with 10 percent nitric acid.

2. Rinse thoroughly with tap water.

3. Wash in dishwasher at wash cycle, using laboratory detergent cycle, followed by tap and analyte free water rinse cycles.

4. Rinse twice with solvent and allow to air dry for at least 24 hours.

5. Replace in covered, automatic sampler base; cover with aluminum foil for storage and mark the base as follows: "Cleaned for organic analyses."

C.3.7 Bottle Siphons for Composite Containers

Tubing should be rinsed with solvent and dried in the drying oven overnight before use. The ends of the siphon should be capped with aluminum foil and/or Teflon® film for storage. The tubing will be sealed in plastic and labeled. The siphon should be flushed with sample thoroughly before use.

C.3.8 Reusable Teflon® Composite Mixer Rods

1. Wash equipment thoroughly with soap and hot tap water using a brush or scrub pad to remove any particulate matter or surface film.

2. Rinse equipment thoroughly with hot tap water.

3. Rinse equipment with at least a 10 percent nitric acid solution.

4. Rinse equipment thoroughly with tap water.

5. Rinse equipment thoroughly with analyte free water.

6. Rinse equipment thoroughly with solvent and allow to air dry for at least 24 hours.

7. Wrap equipment in one layer of aluminum foil. Roll edges of foil into a "tab" to allow for easy removal. Seal the foil wrapped equipment in plastic and label.

When this sampling equipment is used to collect samples that contain oil, grease, or other hard to remove materials, it may be necessary to rinse the equipment several times with pesticide-grade acetone, hexane, or petroleum ether to remove the materials before proceeding with Step 1. In extreme cases, it may be necessary to steam clean the field equipment before proceeding with Step 1. If the equipment cannot be cleaned utilizing these procedures, it should be discarded.

C.4 Cleaning Procedures for Tubing

C.4.1 Silastic® Pump Tubing

The Silastic® pump tubing in the automatic samplers and peristaltic pumps should be replaced after each study. After installation, the exposed ends should be capped with clean, unused aluminum foil.

C.4.2 Teflon® Sample Tubing

Use only new Teflon® tubing which has been pre-cleaned as follows for the collection of samples for trace organic compound or ICP analyses:

1. Teflon® tubing shall be precut in 10, 15 or 25-foot lengths before cleaning.
2. Rinse outside of tubing with solvent.
3. Flush interior of tubing with solvent.
4. After flushing with solvent, pressurize the tubing to a safe level (one end only) to flush out solvent.
5. Dry overnight in the drying oven.
6. Coil. Cap ends with aluminum foil. Wrap tubing in one layer of aluminum foil. Roll edges of foil into a "tab" to allow for easy removal. Seal the foil wrapped tubing in plastic and label.

C.4.3 Stainless Steel Tubing

1. Wash with soap and hot tap water using a long, narrow, bottle brush.
2. Rinse equipment thoroughly with hot tap water.
3. Rinse equipment thoroughly with analyte free water.
4. Rinse equipment thoroughly with solvent and allow to air dry for at least 24 hours.
5. Cap ends with aluminum foil. Wrap tubing in one layer of aluminum foil. Roll edges of foil into a "tab" to allow for easy removal. Seal the foil wrapped tubing in plastic and date.

When this sampling equipment is used to collect samples that contain oil, grease, or other hard to remove materials, it may be necessary to rinse the equipment several times with pesticide-grade acetone, hexane, or petroleum ether to remove the materials before proceeding with Step 1. If the equipment cannot be cleaned utilizing these procedures, it should be discarded.

C.4.4 Glass Tubing

New glass tubing should be cleaned as follows:

1. Rinse thoroughly with solvent.
2. Air dry for at least 24 hours.
3. Wrap tubing completely with aluminum foil and seal in plastic (one tube/pack) to prevent contamination during storage.

C.5 Cleaning Procedures for Miscellaneous Equipment

C.5.1 Well Sounders and Tapes

1. Wash with soap and tap water.
2. Rinse with hot tap water.
3. Rinse with analyte free water.
4. Allow to air dry overnight.

C.5.2 Goulds® Pump

CAUTION - Never plug the pump in while cleaning.

Cleaning:

1. Remove garden hose (if attached), and clean separately.
2. Using a brush or scrub pad, scrub the exterior of the hose, electrical cord and pump with soap and tap water. Do not wet the electrical plug.
3. Rinse with analyte free water.
4. Air dry.
5. Place pump and hose in clean plastic bag and label.

C.5.3 Redi-Flo2® Pump

CAUTION - Make sure that the controller is not plugged in.
CAUTION - Do not wet the controller.

Controller Box Cleaning:

1. Wipe the controller box with a damp cloth. Immediately remove any excess water.
2. Let the controller box dry completely.

Pump Cleaning:

CAUTION - Make sure that the pump is not plugged in.

1. Remove garden hose (if attached) and ball check valve. Clean these items separately.
2. Using a brush or scrub pad, scrub the exterior of the electrical cord and pump with soap and tap water. Do not wet the electrical plug.
3. Place pump in clean water and have it discharge into a bucket or or another area to clean the inside of the pump, using a soap and water mixture first. Then run tap water or DI water through the pump and flush out the soap.

4. Completely air dry.

5. Place equipment in clean plastic bag.

To clean the Redi-Flo2® ball check valve:

1. Completely dismantle ball check valve. Check for wear and/or corrosion, and replace as needed.

2. Using a brush, scrub all components with soap and hot tap water.

3. Rinse with analyte-free water.

4. Completely air dry.

5. Reassemble the ball check valve and re-attach to Redi-Flo2® pump head.

Note: The analyte-free water within the Redi-Flo2® pump head should be changed at the FEC upon return from the field according to the manufacturer's instructions.

C.5.4 Little Beaver®

The engine and power head should be cleaned with a power washer, steam jenny, or hand washed with a brush using soap to remove oil, grease, and hydraulic fluid from the exterior of the unit. Do not use degreasers. Rinse thoroughly with tap water.

Auger flights and bits should be cleaned as follows:

1. Inspect thoroughly. If severe rust, corrosion, paint, or hardened grout is present, the equipment will require sandblasting prior to cleaning.

2. Clean with tap water and soap, using a brush if necessary, to remove particulate matter and surface films. Steam cleaning (high pressure hot water with soap) may be necessary to remove matter that is difficult to remove with the brush. Augers that are steam cleaned should be placed on racks or saw horses at least two feet aboveground.

3. Rinse thoroughly with tap water.

4. Completely air dry. Remove and wrap with clean, unused plastic. Return to storage.

At the direction of the project leader or the Quality Assurance Officer, this equipment may be cleaned as specified in Section C.2.2 prior to use.

C.5.5 Drill Rig, Grout Mixer, and Associated Equipment

- A thorough interior and exterior cleaning of the drill rig is required at the end of each study. The exterior (including undercarriage) should be washed with soap and tap water and then rinsed with tap water. The steam jenny may be used.

- The pump and tank on the drill rig should be flushed with tap water until clear, and then drained.

- The pump on the grout mixer should be flushed with tap water until clear, then drained.

- The grout mixer should be washed with soap and tap water. The steam jenny may be used.

Drilling equipment (tools, rods, augers, etc.) should be cleaned as follows:

1. Inspect thoroughly. If severe rust, corrosion, paint, or hardened grout is present the equipment may require sandblasting prior to cleaning.

2. Clean with tap water and soap, using a brush if necessary, to remove particulate matter and surface films. Steam cleaning (high pressure hot water with soap) may be necessary to remove matter that is difficult to remove with the brush. Drilling equipment that has been steam cleaned should be placed on racks or saw horses at least two feet above ground. Hollow-stem augers, drill rods, etc., that are hollow or have holes that transmit water or drilling fluids, should be cleaned on the inside and outside.

3. Rinse thoroughly with tap water.

4. Let completely air dry. Remove and cover with clean, unused plastic and label.

At the direction of the project leader, Quality Assurance Officer, or drill rig operator, this equipment may be cleaned as specified in Section C.2.2 prior to use.

C.5.6 Miscellaneous Sampling and Flow Measuring Equipment

Flow measuring equipment such as weirs, staff gages, velocity meters, and other stream gaging equipment, and other miscellaneous sampling equipment shall be washed with soap and hot tap water, rinsed with hot tap water, rinsed thoroughly with analyte free water, and completely air dried before being stored. This procedure is not to be used for equipment utilized for the collection of samples for trace organic or inorganic constituent analyses.

C.5.7 Field Analytical Equipment

Field instruments for in-situ water analysis should be wiped with a clean, damp cloth. The probes on these instruments (pH, conductivity, DO, etc.), should be rinsed with analyte-free water and air dried.

Any desiccant in these instruments should be checked and replaced, if necessary, each time the equipment is cleaned.

C.5.8 Ice Chests and Shipping Containers

Ice chests and reusable containers shall be washed with soap (interior and exterior) and rinsed with tap water and air dried before storage. If in the opinion of the field investigators the container is severely contaminated with concentrated waste or other toxic material, it shall be cleaned as thoroughly as possible, rendered unusable, and properly disposed.

C.5.9 Pressure Field Filtration Apparatus

1. Wash equipment thoroughly with soap and hot tap water using a brush to remove any particulate matter or surface film.

2. Rinse equipment thoroughly with hot tap water.

3. Rinse equipment with 10 percent nitric acid solution.

4. Rinse equipment thoroughly with analyte free water.

5. Rinse equipment thoroughly with solvent and allow to air dry for at least 24 hours.

6. Assemble the apparatus and cap both the pressure inlet and sample discharge lines with aluminum foil to prevent contamination during storage.

7. Wrap equipment in one layer of aluminum foil. Roll edges of foil into a "tab" to allow for easy removal. Seal the foil wrapped equipment in plastic and date.

During steps 1 through 5 as outlined above and immediately after assembling, pressure should be applied to the apparatus after each rinse step (water and acid) to drive the rinse material through the porous glass filter holder in the bottom of the apparatus.

When this sampling equipment is used to collect samples that contain oil, grease, or other hard to remove materials, it may be necessary to rinse the equipment several times with pesticide-grade acetone, hexane, or petroleum ether to remove the materials before proceeding with the first step. In extreme cases, it may be necessary to steam clean the field equipment before proceeding with Step 1. If the equipment cannot be cleaned utilizing these procedures, it should be discarded.

C.5.10 Organic/Analyte Free Water Storage Containers

NOTE: These containers will be used only for transporting organic/analyte free water.

1. Wash containers thoroughly (interior and exterior) with hot tap water and laboratory detergent, using a bottle brush to remove particulate matter and surface film.

2. Rinse containers thoroughly with hot tap water.

3. Rinse containers with at least 10 percent nitric acid.

4. Rinse containers thoroughly with tap water.

5. Rinse containers thoroughly with analyte free water.

6. Rinse containers thoroughly with solvent and allow to air dry for at least 24 hours.

7. Cap with aluminum foil or Teflon® film.

8. Store in plastic bags.

When transporting organic/analyte free water to the field, use only containers cleaned as specified above. Thoroughly rinse the interior of the container with organic/analyte free water prior to filling. Cap with one layer of Teflon® film, one layer of aluminum foil, and label the container as "organic/analyte free water" and include the date it was prepared. Do not store the organic/analyte free water at the FEC for more than three days.

C.5.11 Portable Solvent Rinse System

1. Replace Teflon® tubing if necessary. Wash nozzle and tubing fittings with hot, soapy water.

2. Rinse with analyte-free water.

3. Wrap nozzle and tubing ends with aluminum foil.

C.5.12 Splash Suits

CAUTION: Splash suits should be inspected for wear or damage. If, after consultation with the Branch Safety Officer, the suit cannot be repaired, it should be discarded.

1. Wash and brush suit thoroughly inside and out with a brush in hot tap water and soap.

2. Rinse suit thoroughly inside and out with tap water.

3. Hang suit up until completely dry.

4. Fold suit and place in clean, clear plastic bag and tap shut. Mark the suit's size on the bag.

C.5.13 SCBA Face-masks

CAUTION: Face-masks should be inspected for wear or damage. If, after consultation with the Safety Officer, the face-mask cannot be repaired, it should be discarded.

1. Wash face-mask thoroughly inside and out with hot tap water and disinfectant soap. Use only soft brushes. Do not use scouring pads of any type.

2. Rinse face-mask thoroughly inside and out with tap water.

3. Hang face-mask up until completely dry.

4. Place face-mask in plastic bag and return to SCBA case.

APRs are completely dismantled prior to cleaning. Then Steps 1 - 3 for SCBA face-masks are used. When Completely dry, the APR is reassembled and placed in a plastic bag.

C.5.14 Garden Hose

1. Brush exterior with soap and tap water

2. Rinse with tap water.

3. Flush interior with tap water until clear (minimum of one gallon).

4. Let completely air dry.

5. Coil and place in clean plastic bag.

C.5.15 Portable Tanks for Tap Water

1. Scrub interior and exterior with soap and tap water.

2. Rinse with tap water.

3. Let completely air dry.

4. Close.

C.5.16 Vehicles

Vehicles utilized by field investigators should be washed (if possible) at the conclusion of each field trip. This should minimize contamination of equipment or samples due to contamination of vehicles.

When vehicles are used in conjunction with hazardous waste site inspections, or on studies where pesticides, herbicides, organic compounds, or other toxic materials are known or suspected to be present, a thorough interior and exterior cleaning (using soapy tap water) is mandatory at the conclusion of such investigations. It shall be the responsibility of the field investigators to see that this procedure is followed. Personnel involved will use appropriate safety measures.

Vehicles shall be equipped with trash bags and/or trash containers to facilitate vehicle cleaning. Field investigators are responsible for keeping field vehicles clean by removing trash and other debris. Contaminated trash and equipment should be kept separate from ordinary trash and should be properly disposed on-site or upon return (Section 5.15).

C.6 Preparation of Disposable Sample Containers

C.6.1 Introduction

No disposable sample container (with the exception of the glass and plastic compositing containers) may be reused. All disposable sample containers will be stored in their original packing containers. When packages of uncapped sample containers are opened, they will be placed in new plastic garbage bags and sealed to prevent contamination during storage.

Specific pre-cleaning instructions for disposable sample containers are given in the following sections.

C.6.2 Plastic Containers used for "Classical" Parameters

Plastic containers used for oxygen demand, nutrients, classical inorganics, and sulfides have no pre-cleaning requirement. However, only new containers may be used.

C.6.3 Glass Bottles for Semi-Volatile GC/MS Analytes

These procedures are to be used only if the supply of pre-cleaned, certified sample bottles is disrupted. The Quality Assurance Officer will instruct personnel in the proper implementation of these procedures.

If desired, pesticide-grade methylene chloride may be substituted for pesticide-grade isopropanol. In addition, 1:1 nitric acid may be substituted for the 10% nitric acid solution.

When these sample containers are cleaned and prepared, they should be cleaned in standard sized lots of 100 to facilitate the quality control procedures outlined in Section 5.14.

1. Wash bottles and jars, Teflon® liners, and caps in hot tap water and soap.

2. Rinse three times with tap water.

3. Rinse with 10% nitric acid solution.

4. Rinse three times with analyte free water.

5. Rinse bottles, jars, and liners (not caps) with solvent.

6. Oven dry bottles, jars, and liners at 125°C. Allow to cool.

7. Place liners in caps and close containers.

8. Store in contaminant-free area.

C.6.4 Glass Bottles for Volatile GC/MS and TOX Analyses

These procedures are to be used only if the supply of pre-cleaned, certified sample bottles is disrupted. The Quality Assurance Officer will instruct personnel in the proper implementation of these procedures.

When these sample containers are cleaned and prepared, they should be cleaned in standard sized lots of 100 to facilitate the quality control procedures outlined in Section 5.14.

1. Wash vials, bottles and jars, Teflon® liners and septa, and caps in hot tap water and laboratory detergent.

2. Rinse all items with analyte free water.

3. Oven dry at 125°C and allow to cool.

4. Seal vials, bottles, and jars with liners or septa as appropriate and cap.

5. Store in a contaminant free area.

C.6.5 Plastic Bottles for ICP Analytes

These procedures are to be used only if the supply of pre-cleaned, certified sample bottles is disrupted. The Quality Assurance Officer will instruct personnel in the proper implementation of these procedures.

When these sample containers are cleaned and prepared, they should be cleaned in standard sized lots of 100 to facilitate the quality control procedures outlined in Section 5.14.

1. Wash bottles and caps in hot tap water with soap.

2. Rinse both with 10% nitric acid solution.

3. Rinse three times with analyte-free water.

4. Invert bottles and dry in contaminant free environment.

5. Cap bottles.

6. Store in contaminant free area.

APPENDIX D
SAMPLE SHIPPING PROCEDURES

D.1 Introduction

Samples collected during field investigations or in response to a hazardous materials incident must be classified prior to shipment, as either environmental or hazardous materials samples. In general, environmental samples include drinking water, most groundwater and ambient surface water, soil, sediment, treated municipal and industrial wastewater effluent, biological specimens, or any samples not expected to be contaminated with high levels of hazardous materials.

Samples collected from process wastewater streams, drums, bulk storage tanks, soil, sediment, or water samples from areas suspected of being highly contaminated may require shipment as dangerous goods. Regulations for packing, marking, labeling, and shipping of dangerous goods by air transport are promulgated by the International Air Transport Authority (IATA), which is equivalent to United Nations International Civil Aviation Organization (UN/ICAO) (1). Transportation of hazardous materials (dangerous goods) by EPA personnel is covered by EPA Order 1000. 18 (2)

D.2 Shipment of Dangerous Goods

The project leader is responsible for determining if samples collected during a specific field investigation meet the definitions for dangerous goods. If a sample is collected of a material that is listed in the Dangerous Goods List, Section 4.2, IATA, then that sample must be identified, packaged, marked, labeled, and shipped according to the instructions given for that material. If the composition of the collected sample(s) is unknown, and the project leader knows or suspects that it is a regulated material (dangerous goods), the sample may not be offered for air transport. If the composition and properties of the waste sample or highly contaminated soil, sediment, or water sample are unknown, or only partially known, the sample may not be offered for air transport.

In addition, the shipment of pre-preserved sample containers or bottles of preservatives (e.g., NaOH pellets, HCL, etc.) which are designated as dangerous goods by IATA is regulated. Shipment of nitric acid is forbidden on all aircraft. Dangerous goods must not be offered for air transport without contacting the Division dangerous goods shipment designee.

D.3 Shipment of Environmental Laboratory Samples

Guidance for the shipment of environmental laboratory samples by personnel is provided in a memorandum dated March 6, 1981, subject "Final National Guidance Package for Compliance with Department of Transportation Regulations in the Shipment of Laboratory Samples" (3). By this memorandum, the shipment of the following <u>unpreserved</u> samples is not regulated:

- Drinking water
- Treated effluent
- Biological specimens
- Sediment
- Water treatment plant sludge
- POTW sludge

In addition, the shipment of the following preserved samples is not regulated, provided the amount of preservative used does not exceed the amounts found in 40 CFR 136.3 (4) (see Appendix A). It is the shippers' (individual signing the airway bill) responsibility to ensure that proper amounts of preservative are used:

- Drinking water
- Ambient water
- Treated effluent
- Biological specimens
- Sediment
- Wastewater treatment plant sludge
- Water treatment plant sludge

Samples determined by the project leader to be in these categories are to be shipped using the following protocol, developed jointly between US-EPA, OSHA, and DOT. This procedure is documented in the "Final National Guidance Package for Compliance with Department of Transportation Regulations in the Shipment of Environmental Laboratory Samples" (3).

Untreated wastewater and sludge from POTW's are considered to be "diagnostic specimens" (not environmental laboratory samples). However, because they are not considered to be etiologic agents (infectious) they are not restricted and may be shipped using the procedures outlined below.

Environmental samples should be packed prior to shipment by air using the following procedures:

1. Allow sufficient headspace (ullage) in all bottles (except VOC containers with a septum seal) to compensate for any pressure and temperature changes (approximately 10 percent of the volume of the container).

2. Be sure the lids on all bottles are tight (will not leak).

3. Place bottles in separate and appropriately sized polyethylene bags and seal the bags with tape (preferably plastic electrical tape). Up to three VOC bottles may be packed in one Whirl-Pak container.

4. Optionally, place three to six VOC vials in a quart metal can and then fill the can with vermiculite.

5. Select a sturdy cooler in good repair. Secure and tape the drain plug with fiber or duct tape. Line the cooler with a large heavy duty plastic bag.

6. Place two to four inches of vermiculite in the bottom of the cooler and then place the bottles and cans in the cooler with sufficient space to allow for the addition of vermiculite between the bottles and cans.

7. Put "blue ice" (or ice that has been "double bagged" in heavy duty polyethylene bags and properly sealed) on top of and/or between the samples. Fill all remaining space between the bottles or cans with vermiculite.

8. Securely fasten the top of the large garbage bag with tape (preferably plastic electrical tape).

9. Place the Chain-of-Custody Record and the CLP Traffic Report Form (if applicable) into a plastic bag, and tape the bag to the inner side of the cooler lid.

10. Close the cooler and securely tape (preferably with fiber tape) the top of the cooler shut. Chain-of-custody seals should be affixed to the top and sides of the cooler within the securing tape so that the cooler cannot be opened without breaking the seal.

11. Shipping containers must be marked "THIS END UP", and arrow labels which indicate the proper upward position of the container should be affixed to the container. A label containing the name and address of the shipper should be placed on the outside of the container. Labels used in the shipment of hazardous materials (e.g., Cargo Only Air Craft, Flammable Solids, etc.) are not permitted to be on the outside of containers used to transport environmental samples.

D.4 References

1. Dangerous Goods Regulations, International Air Transport Authority (IATA). Current Edition. which changes annually.

2. EPA Order 1000.18, February 16, 1979.

3. "Final Regulation Package for Compliance with DOT Regulations in the Shipment of Environmental Laboratory Samples," Memo from David Weitzman, Work Group Chairman, Office of Occupational Health and Safety (PM-273), US-EPA, April 13, 1981.

4. 40 CFR 136.3. July 1, 2001. See Table 11, Footnote 3.

APPENDIX E
PUMP OPERATING PROCEDURES

E.1 Peristaltic Pump

E.1.1 Introduction

When relatively small volumes of water are required for purging and sampling, and the water level is within the limit of suction (generally around 25 feet vertical separation between the pump and water surface) peristaltic pumps can be used. These pumps are generally small, light-weight, and portable and are powered by 12-volt batteries.

The application of these pumps differs with respect to purging and sampling. The following sections detail the use of peristaltic pumps for both purposes.

E.1.2 Purging with a Peristaltic Pump

1. Place a coil of standard-cleaned (Appendix B) Teflon® tubing, equal to the well depth plus an additional five to ten feet, in a standard cleaned bucket or box which has been lined with clean plastic sheeting or a garbage bag. Enough tubing is needed to run from the ground surface up to the top of the well casing and back down to the bottom of the well. This will allow for operation of the pump at all possible water level conditions in the well.

2. Place one end of the tubing into the vacuum side of the peristaltic pump head. Proper sizing of the Teflon® and Silastic® or Tygon® tubing should allow for a snug fit of the Teflon® tubing inside the flexible tubing mounted in the pump head.

3. Run a short section of tubing (does not have to be Teflon®) from the discharge side of the pump head to a graduated bucket.

4. Place the free end of the coil of Teflon® tubing into the well until the end of the tubing is just below the top of the water column.

5. Secure the Teflon® tubing to the well casing or other secure object using electrician's tape or other suitable means. This will prevent the tubing from being lost in the well should all of the tubing be deployed and come loose from the pump head.

6. Turn on the pump to produce a vacuum on the well side of the pump head and begin the purge. Observe pump direction to ensure that a vacuum is being applied to the purge line. If the purge line is being pressurized, either switch the tubing at the pump head or reverse the polarity of the cables on the pump or on the battery.

7. Purge the well according to the criteria described in Section 7.2 of this manual. If the pumping rate exceeds the recovery rate of the well, continue to lower the tubing into the well several feet at a time, as needed, until the drawdown stabilizes or the well is evacuated to dryness. If the pump is a variable speed peristaltic pump, and the water level in the well is being drawn down, reduce the speed of the pump in an attempt to stabilize the drawdown. If the well can be purged without evacuating the well to dryness, a sample with greater integrity can be obtained.

8. For wells which are not evacuated to dryness, particularly those with recovery rates equal to or very nearly equal to the purge rate, there may not be a complete exchange and removal of stagnant water in that portion of the water column above the tubing intake. For this reason, it is important that the tubing intake be placed in the very uppermost portion of the water column while purging. Standard field measurements should frequently be taken during this process to verify adequacy of the purge (See Section 7.2 for specific details regarding purge adequacy measurements).

E.1.3 Sampling with a Peristaltic Pump

Flexible tubing used in peristaltic pump heads is not acceptable for collecting samples for organic compounds analyses and cannot easily be field cleaned between sampling locations prior to collecting samples for other parameters. For these reasons, it is necessary to use a vacuum container, placed between the pump and the well for sample collection with a peristaltic pump. However, if the flexible pump tubing is decontaminated according to Appendix C of this SOP, samples for analyses of some inorganic constituents may be collected through the tubing if blanks are collected. This method is detailed in the following steps.

NOTE: Samples for volatile organic compound analyses cannot be collected using this method. If samples for VOC analyses are required, they must be collected with a Teflon® or stainless steel bailer or by other approved methods, such as the straw method. The straw method involves allowing the tubing to fill, by either lowering it into the water column or filling it via suction applied by the pump head. Upon filling, the tubing is removed from the well and allowed to drain into the sample vial. This is repeated, as necessary, until all vials are filled.

1. Disconnect the purge tubing from the pump. Make sure the tubing is securely attached to the protective casing or other secure object.

2. Insert the tubing into one of the ferrule nut fittings of a Teflon® vacuum container transfer cap assembly.

3. Place a suitable length of Teflon® tubing between the remaining transfer cap assembly ferrule nut fitting and the vacuum side of the flexible tubing in the peristaltic pump head. Securely hand tighten both fittings.

4. Turn the pump on. Water should begin to collect in the transfer container (typically a 4-liter or 1-gallon sample container) within a few minutes. If water does not begin to flow into the container within five minutes, check the transfer cap fittings and make sure the assembly is tightly attached to the container. It may be necessary to tighten the ferrule nuts with a wrench or pliers to achieve a vacuum in the system, particularly when approaching the maximum head difference between the pump and water table.

5. When the transfer container is nearly full, turn off the pump, remove the transfer cap assembly, and pour the sample into the appropriate containers. Samples to be analyzed for extractable organic compounds, metals, and cyanide can be collected using this system. Because the one-gallon (4-liter) containers used by the Branch are rinsed with nitric acid during cleaning, they cannot be used for collecting samples to be analyzed for nitrogen sensitive parameters.

6. If additional sample volume is needed, replace the transfer cap assembly, turn the pump on, and collect additional volume. The use of Teflon® valves or ball check devices to retain the water column in the sample delivery tubing during the transfer phase, when large volumes of sample are required, is acceptable. These devices, however, must be constructed so that they may be completely disassembled and cleaned according to the procedures in Appendix C.2.1

7. When sampling is completed, all Teflon® tubing should be discarded.

E.2 Large Diameter Electric Submersible Pumps

E.2.1 Introduction

Pumps included within this category are any of the typical, large diameter (3-inch to 4-inch) electric submersibles, such as Goulds®, Grunfos®, or Jacuzzi®. These pumps are necessary when large amounts of water must be removed from wells such as deep, 4-inch monitoring wells and drilled or bored potable wells.

These pumps are generally powered by 120-volt generators and require a minimum of two persons for operation. As such, utmost care should be observed to ensure the safe operation of this equipment, particularly from an electrical hazard standpoint. The following sections detail the safety and operation of these pumps.

E.2.2 Safety

1. Place the generator on dry ground or plastic sheeting as far as practical from the well, in the down-wind direction, and ground it. Several grounding kits consisting of a roll of copper wire and a grounding rod are available. Wet the ground thoroughly with tap water at the grounding location, if dry, and drive the grounding rod several feet into the ground.

2. Inspect the electrical cord for frays, breaks, exposed wiring, etc.

3. Check the head space of the well for the presence of an explosive atmosphere with a combustible gas meter.

4. With the current tripod and spool set-up, a minimum of two people are required to place, retrieve, and operate these pumps safely. If they are used without the aid of the tripod, i.e., all electrical and suspension lines are spooled separately, at least three people are needed to successfully lower and raise the pumps.

5. Wear rubber safety boots to insulate against shock hazards.

6. If purge water is not collected, direct the discharge away from the well and generator, preferably downgradient of area.

7. Make sure that the generator is set to proper voltage.

8. Do not add gasoline or oil to the generator while it is running.

9. Carry the generator, gasoline, and oil in a trailer dedicated to this type of equipment. Do not haul this equipment in the back of any passenger vehicle or with any sampling equipment or containers.

E.2.3 Pre-loadout Checkout Procedure

1. Check the oil and gasoline in generator, filling up as needed. Take generator outside and start it. Place a load on the generator, if possible.

2. Inspect the pump, and all hose, rope and electrical cord and connections.

E.2.4 Operation

1. Erect tripod over well head and load hose spool. Connect pump to steel winch cable. Using winch crank, lower pump, hose and electrical cord into the well. If no tripod is available, lower the pump into the well by hand. This will require at least three people, one to lower pump with the rope, one to feed the hose and cord into the well, maintaining proper tension, and one to feed rope, hose and electrical cord from cart.

NOTE: Keep all hose, electrical cord and cable off of the ground at all times. Do not allow the rope, cord, or the hose to scrape or rub on the well casing.

2. Place pump five feet below the top of the water column.

3. Start generator, <u>then</u> connect power cord from pump.

4. After starting pump, closely observe operation to determine if drawdown is occurring in well. If the water level is not pulled down significantly, keep pump at initial level and continue to purge. If the water level drops, lower the pump to keep up with the drawdown. Do not allow the pump to run dry, as this will damage it.

E.2.5 Maintenance and Precautions

1. Do not put up wet.

2. Empty hose of contaminated water before leaving sampling location. Do not bring back hose with water in it.

3. Do not pump dry.

4. Do not run generator without checking oil.

5. Do not put pump in trailer with generator.

E.2.6 Trouble Shooting

<u>No Power to Pump</u>	1.	Loose connections at pump.	1.	Check wiring at pump. Repair as needed. (Generator Off!!)
	2.	Cord unplugged at generator.	2.	Plug pump back in.
<u>Generator Running, No Pump Output</u>	1.	Pump out of water.	1.	Lower pump into water.
	2.	Hose collapsed or kinked.	2.	Unkink hose.
	3.	Generator output failing.	3.	Put load on generator and check output or check voltage output meter.
<u>Sluggish Discharge</u>	1.	Sediment or other material clogging screen.	1.	Remove material from screen.
	2.	Kinked hose.	2.	Unkink hose.

E.3 QED® Bladder and Purge Pumps

E.3.1 Introduction

Several QED® bladder pumps and purge pumps (no bladder) which can be used for purging monitoring wells are available. Bladder pumps have a very low efficiency when used near the top of the water column and will generally not purge more than 0.5 gallon per minute. The purge pump, however, can achieve pump rates of several gallons per minute in these situations. The efficiency of the bladder pumps is restricted by the rigid Teflon® bladder, which requires significant hydrostatic head for rapid and complete filling. The purge pump, having no bladder, fills much faster under the same conditions.

Both pumps operate by cycling a pressurized gas on and off in a discharge and refill cycle. The gas, usually atmospheric air, is pressurized and regulated by a compressor/regulator combination (controller), which can consist of either a small, battery powered unit, capable of providing pressure to operate the bladder pump at a depth of approximately 75 feet, or a larger, gasoline powered unit that will allow operation at depths of over 150 feet.

E.3.2 Operation - Bladder Pump

1. Connect air supply hose to "pump supply" connection on controller and to brass air connection on hose reel cart.

2. Lower pump into well and place top of pump several feet below the top of the water column.

3. Turn on the compressor. If the gasoline powered compressor is used, place as far from the well as possible, in the down wind direction.

4. Adjust the timing of the discharge and refill cycles until maximum flow is achieved.

5. Lower pump, as necessary, if water level is reduced in well.

E.3.3 Operation - Purge Pump

1. Connect air supply hose to "pump supply" connection on controller and connection on top of pump. Observe flow direction arrow on purge pump exhaust adapter. The arrow must point in the direction of air flow from the controller to the pump.

2. Attach adequate length of standard garden hose to hose fitting at top of pump.

3. Lower pump, air hose and garden hose into water column until top of pump is several feet below top of water column.

4. Follow Steps 3 through 5 above.

E.3.4 Trouble Shooting

Compressor running, no pressure on discharge cycle	1. Air supply fittings loose.	1. Check all fittings and tighten.
	2. Bladder is perforated.	2. Replace bladder.
	3. Exhaust adapter installed in wrong direction.	3. Remove adapter and replace in correct orientation.
Compressor running, pressure low, no water discharged	1. Obstruction in ball check assembly allowing water to be pushed out of pump at check.	4. Remove obstruction.
	2. Air supply fittings loose.	5. Check all fittings.

E.4 Small Diameter Electric Submersible Pumps

E.4.1 Introduction

Included within this category is the Grundfos Redi-Flo2 small diameter electric submersible pump. With a diameter of approximately 1.75 inches, it is designed to be used in 2-inch diameter and larger wells. (Note: If used in any well larger than 4-inch diameter, this pump must be equipped with a cooling shroud to prevent the pump from overheating. If this condition occurs, internal sensors will send a shut-off signal to the controller and the pump will not be operable until it cools to a temperature within the operating range). The Redi-Flo2 is a variable speed pump capable of providing pump rates from less than 100 ml/minute to in excess of 8 gallons per minute.

The pump, depending on the controller being used, operates with either 115v or 220v power. The pump rate is controlled by adjusting the frequency of the current going to the pump motor. It is a light-weight pump and can be easily handled by one person when lowering, but two people are generally needed when removing the pump, one to pull and another to reel in the hose and power lead.

E.4.2 Safety

1. Place the generator on dry ground or plastic sheeting as far as practical from the well, in the down-wind direction, and ground it. Several grounding kits consisting of a roll of copper wire and a grounding rod are available. Wet the ground thoroughly with tap water at the grounding location, if dry, and drive the grounding rod several feet into the ground.

2. Inspect the electrical extension cord, as well as the lead to the pump, for frays, breaks, exposed wiring, etc.

3. Check the head space of the well for the presence of an explosive atmosphere with a combustible gas meter.

4. Wear rubber boots to insulate against shock hazards.

5. If purge water is not collected, direct the discharge away from the well and generator, preferably downgradient of the area.

6. Make sure that the generator is set to the proper voltage.

7. Do not add gasoline or oil to the generator while it is running.

8. Carry the generator, gasoline, and oil in a trailer dedicated to this type of equipment. Do not haul this equipment in the back of any passenger vehicle or with any sampling equipment or containers.

E.4.3 Pre-loadout Checkout Procedures

1. Check the oil and gasoline in the generator, making sure that there is enough gasoline to test the generator prior to loading onto the trailer. Take the generator outside and start. Place a load on the generator, if possible.

2. Inspect the pump and all hoses, rope, and electrical cord and connections. In particular, open the water reservoir on the bottom of the pump and check to make sure that it is full of water. If not, using the syringe in the controller case, top the reservoir off with organic/analyte-free water. Return the pump to its operating vertical position and shake. Re-open the reservoir and add additional water, if needed, to top it off a second time.

E.4.4 Operation

1. Place the pump, the controller, and enough hose for the measured well depth on plastic sheeting next to the well. Set the generator in a dry, safe location downwind of the well, but do not plug the cord from the controller into the generator.

2. After checking the head space of the well for safety, lower the pump, power lead, and hose into the well, placing the pump approximately five feet into the water column.

3. Start the generator, <u>then</u> connect the power cord from the pump. Make sure the proper voltage has been selected.

4. After starting the pump, closely observe operation to determine if drawdown is occurring in the well. If the water level is not pulled down, raise the pump in the water column one to two feet from the top of the water column and continue to purge. If the water level drops, however, lower the pump to keep up with the drawdown. Do not allow the pump to run dry. This condition will create a thermal overload and shut the pump down. While this may not necessarily damage the pump, it will create delays in sampling.

E.4.6 Maintenance and Precautions

1. Empty the hose of contaminated water before leaving the sampling location. Do not bring the hose back to the FEC if it contains purge water from a site.

2. Field clean the pump before leaving the sampling location (see Appendix B).

3. Do not run the generator without first checking the oil.

4. Do not put the pump in the trailer with the generator.

5. If the pump is equipped with a check valve or back flow preventer, periodically check this device to make sure that it is operating. This is a common place for debris or other material to accumulate and interfere with the proper operation of the device.

E.4.7 Trouble Shooting

<u>Generator Running, No Pump Output</u>	1. Loose connection at pump.	1. Check wiring at pump. Repair as needed. (Generator off!!)
	2. Cord unplugged at generator.	2. Plug pump back in.
	3. Over voltage on controller display.	3. Adjust generator output/idle speed; allow generator more warm-up time.
	4. Pump out of water.	4. Lower pump into water.
	5. Hose collapsed or kinked.	5. Unkink hose.
	6. Pump will not run or shuts down with thermal overload signal.	6. Open cooling water reservoir and check cooling water. Add additional organic/analyte-free water to cooling water reservoir.

APPENDIX F
REGIONAL TECHNICAL SUPPORT FOR CRIMINAL INVESTIGATIONS
SESD/CID

The Science and Ecosystem Support Division (SESD) provides technical support to the Atlanta Area and Jacksonville Area Offices, Office of Criminal Enforcement, Forensic and Training, Criminal Investigation Division (CID), for those investigations requiring the collection of samples, laboratory analyses, or other technical support. These procedures address the means by which technical support is requested by the CID Offices and provided by SESD. Detailed technical procedures will be referenced to the various Standard Operating Procedures and Quality Assurance Manuals utilized by SESD.

The primary objectives of SESD support for the CID criminal investigations are to provide accurate, complete, admissible, and defensible reports and data for case development and subsequent legal proceedings. To accomplish these objectives, SESD and the CID Offices have jointly agreed to follow these procedures.

F.1 Technical Assistance Required by the Atlanta Area Office

The CID Offices under the Direction of a Special Agent-in-Charge (SAC) conducts criminal investigations in Region 4 and 14 pursuant to federal environmental laws and regulations. The technical assistance requirements for criminal cases vary from investigation to investigation. To assist the SAC in identifying the type and scope of technical assistance required, a Technical Coordinator position has been established in the Atlanta Area Office. The Technical Coordinator's primary function is to provide technical advice to the SAC and Case Agents. It is the responsibility of the Technical Coordinator to assure that requests for technical support are directed to the appropriate Regional Program and SESD offices. After a decision by the SAC to request technical support for a criminal investigation, the Technical Coordinator will discuss the case with the SESD Director or their designated representative. The SESD Director in consultation and with the concurrence of the Deputy Regional Administrator (DRA) will decide whether or not technical support will be provided by SESD.

Following a decision that technical support will be provided by SESD, the SAC will prepare a written request addressed through the DRA to the SESD Director. Copies of the request will be routed to the appropriate Regional program offices.

Prior to conducting of the investigation, the Technical Coordinator will discuss the case with SESD personnel, and will inform the Case Agent of any technical requirements that may influence project planning. Conversely, it is the responsibility of the Technical Coordinator to inform SESD personnel of all known technical aspects of a case including the presence of any known situations which may pose health and/or safety risks or otherwise interfere with their operations.

Subsequent to the field investigation, the Technical Coordinator in consultation with the Case Agent will discuss with SESD personnel the progress of scheduled analyses and the potential need for additional or more detailed analyses. Information regarding the need to alter work schedules so as to meet changing grand jury or federal court dates will be transmitted immediately from the Technical Coordinator to SESD. When work schedules must be delayed, the technical reasons for the delay will be communicated from the Technical Coordinator to the Case Agent.

Upon completion of analyses and report preparation by SESD, and prior to presentation of the results to a grand jury or federal court, the Technical Coordinator will arrange for an audit and inventory of evidence and files in SESD's possession.

F.2 Project Requests

All requests for SESD support for criminal investigations shall originate with the Atlanta Area or Jacksonville Area Offices. Any information obtained by SESD staff regarding potential criminal activities shall immediately be referred to the appropriate CID Office. Direct requests to SESD from any other federal, state, or local agency shall be referred to the corresponding CID SAC for appropriate action.

Prior to an official request from the CID Office to SESD, an informal contact shall be made with the SESD Senior Enforcement Specialist for the appropriate SESD Branch or Section Chief concerning the availability of resources and expertise necessary for providing the requested technical support. If SESD is able to provide the support, the SAC shall prepare an official request to the SESD Director, through the DRA (with copies to the SESD Senior Enforcement Specialist and the appropriate SESD Branch or Section Chief). For criminal investigations when SESD's priorities prohibit and immediate response, the DRA will determine an appropriate course of action. If the DRA determines that providing the requested technical support will be in the best interest of the Region, the support will be provided and adjustments will be made to other SESD commitments. SESD's technical support may begin immediately after receiving concurrence from the DRA. The SAC has the responsibility of notifying appropriate regional organizational units, e.g., Office Directors, Division Directors, etc., of potential or on-going investigations receiving assistance from SESD or the technical divisions at NEIC.

All emergency requests shall be handled expeditiously. In such instances, SESD may provide the requested assistance immediately upon obtaining verbal approval from the DRA. Either the SAC or the SESD Director may initiate contact with the DRA for emergency requests. However, all such requests shall be followed by a written request from the SAC, through the DRA to the SESD Director.

F.3 Project Coordination

Once the decision has been made to provide technical support, the SESD Director or their designee shall assign the project to the appropriate Branch/Section for assignment of a Project Leader. The Project Leader will be responsible for coordinating with the Case Agent to obtain necessary background information to determine logistical requirements, skill needs, laboratory support, etc.

The Project Leader shall discuss the technical and workload requirements with his/her immediate supervisor. A core team shall then be selected which will eventually conduct the study, coordinate analytical support, and/or provide other technical support. When required, additional staff will be assigned from other Sections or Branches with the approval of the appropriate Branch Chief or SESD Director. Once the core team has been selected, initial planning for the investigation shall begin under the direction of the Project Leader and in concert with the Case Agent.

F.4 Project Planning

After the appropriate or available background material has been obtained, specific assignments will be given to each member of the core team for development of a study plan. Concurrently, the Project Leader shall discuss analytical requirements and time-frames with appropriate SESD, Analytical Support Branch personnel. The study plan and site-safety plan shall be assembled under the direction of the Project Leader and submitted to the appropriate management, and Case Agent for review and concurrence. The time-frame for receiving comments will depend upon the urgency of the investigation, but shall not exceed 10 working days. During emergencies, an investigation may be conducted without the preparation of a detailed study plan. However, during these situations, a memorandum shall be prepared by the Project Leader briefly describing the technical work to be accomplished and stating that the investigation will strictly conform to appropriate SESD Standard Operating Procedures and Quality Assurance Manuals, and Safety Manuals.

A final study plan will be prepared once all appropriate comments are received by the Project Leader. In general, these study plans should contain the following elements. However, upon advice of the Case Agent, the content and format of any study plan may be substantially changed to meet the needs of the particular investigation.

- Introduction -- a brief statement of the problem to be investigated;
- Background – a short but concise history of the case history;
- Objectives -- a statement as to what the investigation is to accomplish and what specific laws and regulations may have been violated;
- Scope – a definition of the limits of the study;
- Time Schedule – a statement outlining when the study will be conducted, analytical results will be available, the draft report will be written, and the final report will be completed;
- Methodology – specific field techniques to be employed. A statement that the techniques in the SESD's Standard Operating Procedures and Quality Assurance Manuals will be employed shall be included. The use of any techniques not included in the Standard Operating Procedures and Quality Assurance Manuals shall be thoroughly justified and must produce evidence which can withstand objections by the defense;
- Analytical Requirements -- an estimate of the number of samples to be collected, required analyses and which laboratory(s) will analyze the samples;
- Logistics -- an estimate of manpower requirements and a general description of specific functions of project personnel, special equipment and vehicles to be used, use of mobile laboratories, how samples are to be transported to the laboratory, etc.; and
- Safety Plan – a safety contingency plan will be included.

F.5 Field Investigation

The field investigation will be conducted under the direct supervision of the Project Leader and the general supervision of the Case Agent responsible for conducting the investigation. SESD will endeavor to meet all objectives set forth in the study plan and any on-scene changes or additional activities requested by the Case Agent. The SESD Project Leader or the SESD Safety Officer shall have sole responsibility for enforcing the provisions of the safety plan. The study will be conducted conforming to the requirements and objectives of the study plan and appropriate Standard Operating Procedures and Quality Assurance Manuals. Any deviations from the study plan or the appropriate Standard Operating Procedures and Quality Assurance Manuals must be approved and documented by the Project Leader. Any deviations must produce evidence which can withstand objections by the defense.

During the field study, the Project Leader or designee is responsible for insuring that all chain-of-custody and quality control procedures for sampling, flow measurements, field analyses, record-keeping, etc., are followed. All field personnel participating in criminal investigations must understand and follow the chain-of-custody and quality control procedures relative to their assignments. Following completion of the field activities, the Project Leader or designee shall account for all field documentation, e.g. field logbooks, sample tags and chain-of-custody records, and verify that they are complete. Sample tags will remain on the sample containers in the custody of the laboratory until relinquishment to the court or final disposition of the case.

F.6 Laboratory Support

A senior analyst shall assist in determining the analytical needs of the investigation and provide overall coordination of sample analyses and data reporting.

Upon delivery of samples to the Science Ecosystem Technology Center custody room, the samples shall be transferred, via chain-of-custody procedures, from the Project Leader or designee to the laboratory Sample Custodian or designee. The Sample Custodian shall document the condition of the samples and verify the uniformity of information on the sample tags and chain-of-custody records prior to placing the samples in the sample custody room.

All sample handling, sample preparation, and analyses shall be in strict conformance with the Analytical Support Branch Operations and Quality Control Manual (ASBOQCM).

The senior analyst shall notify the Project Leader as results become available. Final analytical data shall be reported directly to the Project Leader after all QA/QC procedures have been completed. Any analytical problems or deviations concerning holding times, analytical procedures, etc., shall be reported to the Project Leader. When requested by the Case Agent, this information shall be documented in a memorandum stamped "CONFIDENTIAL", and transmitted to the Project Leader who shall immediately notify the Case Agent. A copy of the memorandum shall also be immediately sent to the Technical Coordinator and the Case Agent as requested.

F.7 Final Report

The Project Leader is responsible for preparing a final investigative report. A draft report shall be prepared for internal review by all core team members and the Case Agent. The draft report may also be reviewed by other appropriate staff, e.g., supervisors and technical experts. All draft reports shall be destroyed upon completion of the final report.

A final investigative report will be prepared by the Project Leader. This report shall be limited to factual information and observations concerning SESD activities, e.g., sampling, analyses, etc., but shall not contain conclusions, recommendations, or personal opinions. At the request of the Case Agent, a memorandum will be prepared containing conclusions, recommendations, or personal opinions. When this is done, the memorandum will be stamped "CONFIDENTIAL" on each page and delivered to the Case Agent. The final report(s) shall be delivered to the Case Agent who shall be responsible for ultimate distribution.

F.8 Document Control

The core team members are responsible for the initial collection and maintenance of all SESD documents, records, and evidence obtained during the field investigation. The documents, records and evidence shall be delivered to the Project Leader at the competition of the field investigation. The Project Leader shall immediately construct an inventory of all such materials obtained. If requested, the Project Leader will deliver all such materials to the Case Agent.

All original analytical data and supporting documentation, e.g., chromatograms, mass spectra, QA/QC records, calculations, etc., shall be maintained by the Analytical Support Branch according to their Laboratory Operations and Quality Assurance Manual. If requested, copies of all records shall be provided to the Case Agent. Dissemination of such records shall only occur under federal court order, as directed by DOJ, or as directed by the prosecuting attorney. The Laboratory Coordinator shall construct a project file of all laboratory data and supporting documentation immediately after completing analyses and reporting of data to the Project Leader. An inventory of that file will be prepared and furnished to the Project Leader and the Case Agent.

All documents, records, evidence, etc., retained by the SESD will be maintained in a locked filing cabinet or a secure area under the direct control of the appropriate Branch Chief, Section Chief, or the custodian of SESD's central records center.

F.9 Sample Disposal

All excess samples and/or sample containers shall be maintained in the sample custody room until written authorization for sample disposal is received from the Case Agent. Because of insufficient space in the sample custody room, the Case Agent shall expeditiously inform the laboratory when samples can be disposed. Sample disposal procedures shall be as described in the Analytical Support Branch Laboratory Operations and Quality Assurance Manual.

APPENDIX G
BATTERY CHARGING AND STORAGE OPERATIONS

PERFORMANCE OBJECTIVES:

- To insure that field batteries are properly charged and maintained.
- To insure that field battery charging is conducted in a safe and efficient manner.
- To provide a means for keeping an inventory of the status and number of field batteries on hand.

G.1 Receiving Batteries from the Field

Upon return from the field, batteries may or may not require maintenance and charging. The following procedure will be used to process incoming batteries.

CAUTION
DANGER OF EXPLODING BATTERIES

Batteries generate explosive gasses. Keep sparks, flames, burning cigarettes, cigars, or other ignition sources away at all times. Always shield eyes when working near batteries. Charge batteries only in well ventilated areas. Wear protective covering when working around batteries.

DANGER OF ACID BURNS

Always wear a face shield, protective coat, and rubber gloves when handling batteries. In case of skin contact with acid, immediately wash affected area for 15 minutes, using safety shower, eye wash, or sink as required. Seek medical attention as soon as possible. Notify the designated Safety Officer or management in the event of injury.

Procedure

Only designated persons are allowed entry into the battery charging building.

1. Check batteries for proper electrolyte level; if necessary, use battery filler to add tap water until levels in each cell are mid-way between the two level marks on the case. Insure that cell filler cap vents are clear. Replace filler caps immediately after filling.

2. Check battery terminals for cleanliness, and clean with wire brush if necessary.

3. Check batteries with load tester. Batteries which register in the green arc can be placed back in a battery box and stored in the "Charged Battery Area". Batteries which register below the green arc are to be removed from the battery box and stored in the "Discharged Battery Area". Empty battery boxes are to be stored beside the sink in the battery building using care not to block access to the safety shower.

G.2 Charging Batteries

Battery charging equipment is to be operated only by trained personnel who are familiar with these procedures. If at any time personnel are not absolutely sure of what to do, work should stop immediately and assistance should be sought. NOTE: Charger will not operate on less than four batteries.

CAUTION

DANGER OF EXPLODING BATTERIES

Batteries generate explosive gasses. Keep sparks, flames, burning cigarettes, cigars, or other ignition sources away at all times. Always shield eyes when working near batteries. Charge batteries only in well ventilated areas. Wear protective covering when working around batteries.

DANGER OF ELECTRICAL SHOCK

Never touch output leads while charger switch is on. Charger's maximum output is 280 volts at 9.5 amps.

DANGER OF ACID BURNS

Always wear face shield, protective coat, and rubber gloves when handling batteries. In case of skin contact with acid, immediately wash affected area for 15 minutes, using safety shower, eye wash, or sink as required. Seek medical attention as soon as possible. Notify the designated Safety Officer or management in the event of any injury.

Procedure

1. Insure that the 240 volt power supply box is locked in the "OFF" position.

2. Insure that the Charger Power Switch is in the "OFF" position.

3. Insure that the Charger Control Knob is set at "0".

4. Inspect all terminal clips for broken insulation and proper connection.

5. Clean all terminal clips with a wire brush.

6. Place the batteries in the charger bench so that the battery numbers are visible from the front and that the battery terminals are to the right when facing the bench. In this configuration, the positive terminals of all batteries will be to the front of the charging bench.

7. Connect the terminal clips securely to the battery terminals. Dirty terminal clips, dirty battery terminals, or loose connections will result in dangerous arcing when the charger is turned on.

8. Insure that the charger's positive lead is attached to the positive terminal of the battery on the right hand facing end of the bench and that the charger's negative lead is attached to the negative terminal of the battery on the left hand facing end of the bench.

9. Remove all battery cell filler caps and store them in the box on the battery bench. Insure that the battery electrolyte level is between fill lines. If low, add tap water with the battery filler. If high, use battery filler to remove the excess electrolyte and dispose of it in the carboy labeled "Battery Acid".

10. Unlock the 240 volt power supply box and place lock on top of the box. Do not place lock back in the lock-out holes for storage as this will prevent a rapid turn off of the system in an emergency.

11. Place the 240 volt power supply box switch in the "ON" position.

12. Set the charger's timer as follows:

    For 4-7 batteries, set timer to 6 hours.
    For 8-11 batteries, set timer to 9 hours.
    For 12-18 batteries, set timer to 12 hours.

    Never operate the charger with the timer in "Hold" position.

13. Recheck the charger's control knob to insure it is on "0", and then place the charger's power switch to "ON".

14. SLOWLY increase the charger's control knob until a reading of between 7 and 8 amps is obtained on the amp meter.

    WARNING

    Never exceed a reading of more than 8 amps output from the charger.

    Always advance the control knob slowly. In the event of a bad contact, arching of the charge current will occur and can result in an excessive flow of current to the batteries.

15. Observe the batteries for a few minutes to insure that none are boiling over.

G.3 Post-Charging

After batteries have charged for the amount of time set on the charger, the following procedure will be used to shut-down the charger and to remove and store charged batteries.

CAUTION
DANGER OF EXPLODING BATTERIES

Batteries generate explosive gasses. Keep sparks, flames, burning cigarettes, cigars, or other ignition sources away at all times. Always shield eyes when working near batteries. Charge batteries only in well ventilated areas. Wear protective covering when working around batteries.

DANGER OF ELECTRICAL SHOCK

Never touch output leads while charger switch is on. Charger's maximum output is 280 volts at 9.5 amps.

DANGER OF ACID BURNS

Always wear face shield, protective coat, and rubber gloves when handling batteries. In case of skin contact with acid, immediately wash affected area for 15 minutes, using safety shower, eye wash, or sink as required. Seek medical attention as soon as possible. Notify the designated Safety Officer or management in the event of any injury.

Procedure

1. Turn charger's control knob to "0".

2. Place charger's power switch in the "OFF" position.

3. Place the 240 volt power supply box switch in the "OFF" position and lock out the switch.

4. Replace all battery cell filler caps.

5. Disconnect all terminal clips.

6. Check all batteries with the load tester. Any batteries not indicating in the green arc, or slightly above will be red-tagged and stored in the "Discharged Battery Area". Those batteries indicating a sufficient charge on the load tester are to be placed in a battery box and stored in the "Charged Battery Area".

7. Record the status of all batteries removed from the bench in the "Battery Log Book".

G.4 Maintenance

During the first week of each month, the following maintenance procedures will be performed at the battery building. The individual performing the maintenance will complete a maintenance report and submit it to the designated Safety Officer.

Procedure

1. Sweep floor

2. Empty trash can

3. Check battery acid carboy. If more than half full, note on the maintenance report.

4. Check contents of the acid spill kit. If contents have been depleted, note on the maintenance report.

5. Check contents of the first aid kit. If contents have been depleted, note on the maintenance report.

6. Check operation of safety shower and eye wash.

7. Check all batteries in the "Charged Battery Area" with the load tester. Any batteries testing below the green arc of the load tester should be removed from their battery box, red-tagged with the notation "Failed Monthly Check" and date of check, and placed in the "Discharged Battery Area".

FIGURE G.1
BATTERY LOG

BATTERY NUMBER	DATE CHARGED	CHARGE YES/NO	INIT

BATTERY NUMBER	DATE CHARGED	CHARGE YES/NO	INIT

FIGURE G.2
BATTERY BUILDING
MAINTENANCE REPORT

DATE:_______________

			COMMENTS
1.	Floor Clean (Y/N)	_____	______________________________
2.	Trash Can Empty (Y/N)	_____	______________________________
3.	Carboy Under Half Full (Y/N)	_____	______________________________
4.	Acid Spill Kit OK (Y/N)	_____	______________________________
5.	First Aid Kit OK (Y/N)	_____	______________________________
6.	Safety Shower/Eye Wash OK (Y/N)	_____	______________________________
7.	Charged Battery Status Enter # In Stock	_____	______________________________

SIGNED:____

NOTE: SEND COMPLETED REPORT TO BRANCH SAFETY OFFICER

APPENDIX H
TECHNICAL SYSTEMS AUDIT FORM QUESTIONNAIRE

Agency

Address

Telephone Number

Reporting Period (beginning-ending dates)

Organization Director

Air Program Supervisor

Data Management Supervisor

Quality Assurance Officer

Questionnaire Completed

(date) (by)

On-Site Visit

Date: Audit Team Members:

Affiliation of Audit Team

A. NETWORK MANAGEMENT

1. General

Complete the table below for each of the pollutants monitored as part of your air monitoring network							
	SO_2	NO_2	CO	O_3	PM-10	PM-2.5	Pb
NAMS							
SLAMS							
SPM PAMS							
Total							

Describe any changes which will be made within the agency's monitoring program the next calendar year

Question	**Yes**	**No**	**Comment**
What is the most current official SLAMS Network Description?			
I. Is it available for public inspection ?			
II. Does it include the following for each site ?			
Monitor ID Code (AIRS Site ID#)			
Sampling and Analysis Method			
Operative Schedule			
Monitoring Objective and Scale of Representativeness			
Any Proposed Changes			

Modification since last audit date of last audit			
	Number of Monitors		
Pollutant	**Added**	**Deleted**	**Relocated**
SO_2			
NO_2			
CO			
O_3			
PM-10			
PM-2.5			
Pb			

2. Network Design and Siting

Indicate by Site ID # any non-conformance with the requirements of 40 CFR 58, Appendices D and E		
Monitor	**Site ID**	**Reason for Non-Conformance**
SO_2		
O_3		
CO		
NO_2		
PM-10		
PM-2.5		
Pb		

Question	**Yes**	**No**	**Comment**
Have NAMS hard copy information reports been prepared and submitted for all monitoring sites within the network?			
Does each site have the required information including:			
AIRS Site ID Number?			
Photographs/slides to the four cardinal compass points?			
Startup and shutdown dates?			
Documentation of instrumentation?			
Reasons for periods of missing data?			
Who has custody of the current network documents ?			Name: Title:
Does the current level of monitoring effort, site placement, instrumentation, etc., meet requirements imposed by current grant conditions?			
How often is the network design and siting reviewed?			Frequency: Date of last review:

Provide a summary of the monitoring activities conducted as the SLAMS/NAMS network by the agency		
I. Monitoring is *seasonal* for (indicate pollutant and month of high and low concentrations).		
Pollutant	**High Concentrations**	**Low Concentrations**

II Monitoring is *year-round* for (indicate pollutant)	
Pollutant	**Collocated (Y/N)**

Question	Yes	No	Comment
Does the number of collocated monitoring sites meet the requirements of 40 CFR 58 Appendix A?			
Does the agency monitor and/or analyze for non-criteria air and /or toxic air pollutants?			

If yes complete forms below

Pollutant	Monitoring Method/Instrument	SOP Available (Y/N)

3. Organization, Staffing and Training

Number of individuals available to each of the following program areas		
Program Area	Number	Comment on need for additional personnel
Network Design and Siting		
Resources and Facilities		
Data and Data Management		
QA/QC		

Question	Yes	No	Comment
Does the agency have an established training program?			
I Where is it documented			
Does it make use of seminars, courses, EPA sponsored college level courses?			

4. Facilities

Identify the principal facilities where the work is performed which is related to the SLAMS/NAMS network. Do not include monitoring sites but do include any work which is performed by contract or other arrangements		
Facility	**Location**	**Main SLAMS/NAMS Function**

Indicate any areas of facilities that should be upgraded. Identify by location

Are there any significant changes which are likely to be implemented to agency facilities before the next systems audit? Comment on your agency's needs for additional physical space (laboratory, office, storage, etc.)		
Facility	**Function**	**Proposed Change - Date**

B: FIELD OPERATIONS

1. Routine Operations

Question	Yes	No	Comment
On average, how many sites does a single site operator have responsibility for?			
How many of the sites of your SLAMS/NAMS network are equipped with manifolds(s)			
I Briefly describe most common manifold type			
II Are manifolds cleaned periodically ?			How often?
IV Are manifold(s) equipped with a blower ?			
V Is there sufficient air flow through the manifold at all times?			Approximate air flow:
VI Is there a conditioning period for the manifold after cleaning?			Length of time:
I)What material is used for instrument lines? 2) How often are lines changed?			

l) Please comment briefly and prioritize your currently identified instrument needs

2. Quality Control

Please indicate frequency of multi point calibrations	
Pollutant	**Frequency**
SO2	
NO2	
CO	
O3	
PM10	
Pb	
PM2.5	

Please list the authoritative standards used for each type of flow measurement, indicate the frequency of calibration standards to maintain field material/device credibility		
Flow Device	**Primary Standard**	**Frequency of Calibration**

Please complete the table below for your agency's site standards.			
Parameter	**Primary Standard**	**Secondary Standard**	**Recertification Frequency**
CO			
NO_2			
SO_2			
O_3			

Question	**Yes**	**No**	**Comment**
Are level 1 zero and span (z/s) calibrations (or calibration checks made for all continuous monitoring equipment and flow checks made for PM 10 and PM2.5 samplers?			
Does the agency have acceptance criteria for zero/span checks?			
I. Are these criteria known to the field operations personnel?			
II. Are they documented in standard operating procedures?			If not indicate document and section where they can be found.
III. Do the documents discussed in (II) above indicate when zero/span adjustments should and should not be made?			
In keeping with 40 CFR 58 regulations, are any necessary zero and span adjustments made after precision checks?			If no, why not?
Are precision check control charts maintained?			
Are precision checks routinely performed within concentration ranges and with a frequency which meets or exceeds the requirements of 40 CFR 58, Appendix A?			Please comment on any discrepancies

3. Preventive Maintenance

Has the field operator been given any special training in performing preventive maintenance? Briefly comment on background and/or courses.

Is this training routinely reinforced? Yes ___ No____
If no, why not?

Comment briefly on the adequacy and availability of the supply of spare parts, tools and manuals available to the field operator to perform any necessary maintenance activities. Do you feel that this is adequate to prevent any significant data loss?

Is the agency currently experiencing any recurring problem with equipment or manufacturer(s)? If so, please identify the equipment and/or manufacturer, and comment on steps taken to remedy the problem.

4. Record Keeping

Question	Yes	No	Comment
Is a record maintained at each site to document site visits, preventive maintenance and resolution of site operational problems and corrective actions taken?			Other uses?
Is the record maintained currently and reviewed periodically?			Frequency of Review
Once entries are made and all the record completed, is it sent to the laboratory for archiving?			If no, is it stored at other location(s) (specify)
What other records are used?			
Zero/span record?			
Maintenance log?			
Log of precision checks?			
Control charts?			
A record of audits?			
Are calibration records or at least calibration constants available to field operators?			

5. Data Acquisition and Handling

With the exception of PM 10, are instrument outputs (that is data) recorded to (a) stripcharts, (b) magnetic tape acquisition system, (c) digitized and telemetered directly to agency headquarters? Please complete the table below for each of the reporting organizations, or agencies within the overall R.O.

Reporting Organization	Pollutants	Data Acquisition Media (a, b, c or combination)

Question	Yes	No	Comment
Is there a stripchart backup for all continuous analyzers?			
On High-volume samplers without flow controllers?			Log sheet____, Dixon chart___ , Other ______ (specify)

What kind of recovery capabilities for data acquisition equipment are available to the field operator after power outages, storms, etc? Briefly describe below.

C. LABORATORY OPERATIONS (WHERE APPLICABLE)

1. Routine Operations

What analytical methods are employed in support of your air monitoring network?

Analysis	Methods
PM-10	
Pb	
PM 2.5	
Others (list by pollutant)	

Question	Yes	No	Comment
Do any laboratory procedures deviate from the reference, equivalent, or approved methods?			If yes, are the deviations for lead analysis ______, PM-10 filter conditioning_____ or other _____ (specify below)?
Have the procedures and/or any changes been approved by EPA?			Date of Approval
Is the documentation of Laboratory SOP complete?			

Is sufficient instrumentation available to conduct your laboratory analyses? Yes___ No___ If no, please indicate instrumentation needs

Instrument Needed	Analysis	New or Replacement	Year of Acquisition

2. Quality Control

Please complete the table for your agency's laboratory standards.

Parameter	Primary Standard	Secondary Standard	Recertification Schedule
Weights			
Temperature			
Moisture			
Barometric Pressure			
Flow			
Lead			
Sulfate			
Nitrate			

Comment on the traceability of chemicals used in the preparation of calibration standards.

Question	**Yes**	**No**	**Comment**
Does the laboratory purchase standard solutions such as those for use with lead or other AA analysis?			
Are all calibration procedures documented?			Where?____________ ____________ (title) (revision)
Are at least one duplicate, one blank, and one standard or spike included with a given analytical batch?			Identify analyses for which this is routine operation

Briefly describe the laboratory's use of data derived from blank analyses.

Question	**Yes**	**No**	**Comment**
Do criteria exist which determine acceptable/non-acceptable blank data?			

How frequently and at what concentration ranges does the lab perform duplicate analysis? What constitutes acceptable agreement?
How does the lab use data from spiked samples? Please indicate what may be considered acceptable percentage recovery by analysis? Please complete the table below

Pollutant	**% Recovery Acceptance Criteria**

Question	**Yes**	**No**	**Comment**
Do criteria exist for "real time quality control based on the results obtained for the mid-range standards?			
Are appropriate acceptance criteria documented for each type of analysis conducted?			
Are they known to the analysts working with respective instruments?			

3. Preventive Maintenance

Question	**Yes**	**No**	**Comment**
Is a maintenance record maintained for each major laboratory instrument?			Comment

4. Record Keeping

Question	**Yes**	**No**	**Comment**
Does a chain-of-custody procedure exist for laboratory samples?			If yes, indicate date, title and revision number where it can be found.
Are records kept for all analytical laboratory instruments?			
Do these records indicate:			
analytical batches processed?			
quality control data?			
calibration data?			
results of blanks, spikes and duplicates?			

Question	Yes	No	Comment
initials of analyst?			
Is there a record which indicates the checks made on: weights			
humidity indicators?			
balances?			
thermometer(s)?			
Are records maintained to track the preparation of filters for the field?			
Are they current?			
Do they indicate proper use of conditioning?			
Weighing?			
Are records kept which track filters returning from the field for analysis?			
How are data records from the laboratory archived? Where? How long are records kept? ________Years			

5. Data Acquisition and Handling

Question	Yes	No	Comment
Are QC data readily available to the analyst during a given analytical run?			
What is the laboratory's capability with regard to data recovery? In case of problems, can they recapture data or are they dependent on computer operations? Discuss briefly.			
Has a users manual been prepared for the automated data acquisition instrumentation?			Comment
Is it in the analyst's or user's possession?			
Is it current?			

6. Specific Pollutants: PM-10, PM 2.5 and Lead

Question	Yes	No	Comment
PM10 and PM 2.5			
Are filters supplied by EPA used at SLAMS sites?			
Are filters visually inspected via strong light from a view box for pinholes and other imperfections?			If no, comment on way imperfections are determined?
Are unexposed filters equilibrated in controlled conditioning environment which meets or exceeds the requirements of 40 CFR 50?			If no, why not?
Is the conditioning environment monitored?			Indicate frequency
Are the monitors properly calibrated?			Indicate frequency
Is the balance checked with Class "S" weights each day it is used?			If no, indicate frequency of such checks
Is the balance check information placed in QC logbook?			If no, where is it recorded?
Is the filter weighed to the nearest milligram?			If not, what mass increment
Are filter serial numbers and tare weights permanently recorded?			If no, indicate where
Are filters packaged for protection while transporting to and from the monitoring sites?			
How often are filter samples collected? (Indicate average lapse time (hrs.) between end of sampling and laboratory receipt.)			
Are exposed filters reconditioned for at least 24 hrs in the same conditioning environment as for unexposed filters?			If no, why not?
Are exposed filters removed from folders, etc., before conditioning?			
Is the exposed filter weighed to the nearest milligram?			
Are exposed filters archived?			Where? Indicate retention period
Are blank filters re-weighed? (PM2.5)			If no, explain why not. If yes, how frequently?
Are analyses performed on filters?			Indicate analyses other than Pb and mass which are routinely performed.
Are sample weights and collection data recorded?			
<u>LEAD</u>			
Is analysis for lead being conducted using atomic absorption spectrometry with air acetylene flame?			If not, has the Agency received an equivalency designation of their procedure?
Is either the hot acid or ultrasonic extraction procedure being followed precisely?			Which?
Is Class A borosilicate glassware used throughout the analysis?			

Question	**Yes**	**No**	**Comment**
Is all glassware scrupulously cleaned with detergent, soaked and rinsed three times with distilled-deionized water?			If not, briefly describe or attach procedure.
If extracted samples are stored, are linear polyethylene bottles used?			
Are all batches of glass fiber filters tested for background lead content?			
At a rate of 20 to 30 random filters per batch of 500 or greater?			Indicate rate
Are ACS reagent grade HNO_3 and HCI used in the analysis?			If not, indicate grade used
Is a calibration curve available having concentrations that cover the linear absorption range of the atomic absorption instrumentation?			
Is the stability of the calibration curve checked by alternately remeasuring every 10th sample a concentration $\leq 1 \mu g$ Pb/ml; $\leq 10\ \mu g$ Pb/ml?			If not, indicate frequency.
Are measured air volumes corrected to reference conditions as given in CFR regulations (Q_{std} of 760 mm Hg and 25 °C) prior to calculating the Pb concentration?			If not, indicate conditions routinely employed for both internal and external reporting.
In either the hot or ultrasonic extraction procedure, is there always a 30-min H_2O soaking period to allow HNO_3 trapped in the filter to diffuse into the rinse water?			
Is a quality control program in effect that includes periodic quantification of (1) lead in 3/4" x 8" glass fiber filter strips containing 100-300 μg Pb/strip, and/or (2) a similar strip with 600-1000μg strip, and (3) blank filter strips with zero Pb content to determine if the method, as being used, has any bias?			Comment on lead QC program or attach applicable SOP
Are blank Pb values subtracted from Pb samples assayed?			If not, explain why

D: DATA AND DATA MANAGEMENT

1. Data Handling

Question	Yes	No	Comment
Is there a procedure, description, or a chart which shows a complete data sequence from point of acquisition to point of submission of data to EPA?			
Are data handling and data reduction procedures documented?			
For data from continuous analyzers?			
For data from non-continuous methods?			
Is there documentation accompanying the data regarding any media changes, transcriptions, and/or flags which have been placed into the data before data are released to agency internal data processing? Describe.			
Have special data handling procedures been adopted for air pollution episodes?			If yes, provide brief description

2. Software Documentation

Question	Yes	No	Comment
Does the agency have available a copy of the AIRS Manual?			
Does the agency have the PARS user's guide available?			
Does the Data Management Section have complete software documentation?			If yes, indicate the implementation date and latest revision dates for such documentation.
Are the computer system contents, including ambient air monitoring data backed up regularly?			Briefly describe, indicating at least the media, frequency, and backup-media storage location
What is the recovery capability (how much time and data would be lost) in the event of a significant computer problem?			

3. Data Validation and Correction

Question	Yes	No	Comment
Have validation criteria, applicable to all pollutant data processed by the reporting organization been established and documented?			
Does documentation exist on the identification and applicability of flags (i.e., identification of suspect values) within the data as recorded with the data in the computer files?			

Question	Yes	No	Comment
Do documented data validation criteria address limits on and for the following:			
I. Operational parameters, such as flow rate measurements or flow rate changes			
II. Calibration raw data, calibration validation and calibration equipment tests.			
III. All special checks unique to a measurement system			
IV. Tests for outliers in routine data as part of screening process			
V. Manual checks such as hand calculation of concentrations and their comparison with computer-calculated data			
Are changes to data submitted to NADB documented in a permanent file?			If no, why not?
Are changes performed according to a documented Standard Operating Procedure or your Agency Quality Assurance Project Plan?			If not according to the QA Project Plan, please attach a copy of your current Standard Operating Procedure
Who has signature authority for approving corrections? (Name) (Program Function)			
Is the group supplying data provided an opportunity to review data and correct erroneous entries?			If yes, how?
Are corrected data resubmitted to the issuing group for cross-checking prior to release?			

4. Data Processing

Question	Yes	No	Comment
Does the agency generate data summary reports?			
Are the data used for in-house distribution and use?			
Publication ?			Other (specify)

Question	Yes	No	Comment
Have special procedures been instituted for pollution index reporting?			.
Who at the agency has the responsibility for submitting data to AIRS? Name Title			
Are those persons different from the individuals who submit data to PARS?			

Question	Yes	No	Comment
If yes, provide name and title of individual responsible for PARS data submittal. Name Title			
How often are data submitted to: - AIRS ? PARS?			
Does the agency routinely request a hard copy printout on submitted data:			
from AIRS?			
from PARS?			
Are records kept for at least 3 years by the agency in an orderly, accessible form?			If yes, does this include raw data__ , calculation__ , QC data__, and reports__? If no, please comment.
Do field data include the following documentation:			
Site ID?			
Pollutant type?			
Date received at the center?			
Collection data (flow, time date)?			
Date of Laboratory Analysis /if applicable)			
Operator/Analyst?			
Are data reduction audits performed on a routine basis?			If yes, at what frequency?
Are they done by an independent group?			
Are precision and accuracy data checked each time they are recorded, calculated or transcribed to ensure that incorrect values are not submitted to EPA?			
Is a final data processing check performed prior to submission of any data?			If no, explain

5. Internal Reporting

Question	Yes	No	Comment
Does the agency prepare Precision and Accuracy summaries other than Form 1?			
Do either the audit or precision reports indicated include a discussion of corrective actions initiated based on audit or precision results?			

Who has the responsibility for the calculation and preparation of data summaries? To whom are such P and A summaries delivered?			
Name	**Title**	**Type of Report**	**Recipient**

Identify the individual within the agency who receives the results of the agency's participation in the NPAP and the internal distribution of the results once received.
Principal Contact for NPAP is (name, title)

6. External Reporting

What number of the SLAMS sites (by pollutant) reported less than 75% of the data (adjusted for seasonal monitoring and site start-ups and terminations)?				
Number of Sites <75% Data Recovery FY____				
Pollutant	**1st Quarter**	**2nd Quarter**	**3rd Quarter**	**4th Quarter**
Ozone				
Nitrogen Dioxide				
Sulfur Dioxide				
Carbon Monoxide				
PM-10				
Lead				

Question	**Yes**	**No**	**Comment**
Does the agency's annual report (as required in 40 CFR 58.26) include the following?			
Data summary required in Appendix F			
Annual precision and accuracy information described in Section 5.2 of Appendix A.			
Location, date, pollution source and duration of all episodes reaching the significant harm levels.			
Certification by a senior officer in the State or his designee.			
Please provide the dates at which the annual reports have been submitted for the last 2 years.			

E. QUALITY ASSURANCE/QUALITY CONTROL

1. Status of Quality Assurance Program

Question	Yes	No	Comment
Does the agency have an EPA-approved quality assurance program plan?			
If yes, have changes to the plan been approved by the EPA?			
Please provide: Date of Original Approval	Date of Last Revision		Date of Latest Approval
Do you have any revisions to your QA Program Plan still pending?			
Is the QA Plan fully implemented?			
Are copies of QA Plan or pertinent sections available to agency personnel?			If no, why not?
Which individuals routinely receive updates to QA Plan?			

2. Audits and Audit System Traceability

Question	Yes	No	Comment
Does the agency maintain a separate audit/calibration support facility laboratory?			
Has the agency documented and implemented specific audit procedures?			
Have audit procedures been prepared in keeping with the requirements of Appendix A to 40 CFR 58?			
Do the procedures meet the specific requirements for independent standards and the suggestions regarding personnel and equipment?			
Are SRM or CRM materials used to routinely certify audit materials?			
Does the agency routinely use NBS-SRM or CPM materials?			For audits only?__ For calibrations only?__ For both?__ For neither, secondary standards are employed__
Does the agency audit the Meteorological sites?			

Please list below areas routinely covered by this review, the date of the last review, and changes made as a direct result of the review.

Pollutants	Audit Method	Audit Standard
CO		
O_3		
NO_2		
$S0_2$		
PM-10		
PM 2.5		

Question	Yes	No	Comment
Are SRM or CRM materials used to establish traceability of calibration and zero/span check materials provided to field operations personnel?			
Specifically for gaseous standards, how is the traceability of audit system standard materials established?			
Are they: purchased certified by the vendor?			
Certified by the QA support laboratory which is part of this agency?			
Are all agency traceability and standardization methods used documented?			
Do the traceability and standardization methods conform with the guidance of VOL. II of the Handbook for Air Pollution Measurement Systems?			
For permeation devices?			
For cylinder gases?			
Does the agency have identifiable auditing equipment (specifically intended for sole use) for audits?			If yes, how is the equipment identified?
How often is auditing equipment certified for accuracy against standards and equipment of higher authority?			

3. National Performance Audit Program (NPAP) And Additional Audits

Identify the individual with primary responsibility for the required participation in the National Performance Audit Program.

For gaseous materials? (name, title)

For laboratory materials? (name, title)

Question	Yes	No	Comment
Does the agency currently have in place any contracts or similar agreements either with another agency or outside contractor to perform any of the audits required by 40 CFR 58?			
If yes, has the agency included QA requirements with this agreement?			
Is the agency adequately familiar with their QA program?			
Date last systems audit was conducted	**Date:**		**By Whom:**

Question	Yes	No	Comment
Does the agency participate in the National Performance Audit Program (NPAP) as required under 40 CFR 58 Appendix A?			If no, why not? Summarize below.

Please complete the table below	
Parameter Audited	**Date of Last NPAP**
SO_2	
CO	
Pb	
PM-10	
O_3	
NO_2	

4. Documentation and Data Processing Review

Question	Yes	No	Comment
Does the agency periodically review its record-keeping activities?			

Question	Yes	No	Comment
Are data audits (specific re-reductions of strip charts or similar activities routinely performed for criteria pollutants data reported by the agency?			If no, please explain.
Are procedures for such data audits documented?			
Are they consistent with the recommendations of Sections 16.4.2.3 of Vol. II of the QA Handbook for Air Pollution Measurement Systems?			If no, why not?

What is the frequency and level (as a percentage of data processed of these audits?			
Pollutant	**Audit Frequency**	**Period of Data Audited**	**% of Data Rechecked**

Identify the criteria for acceptable/non-acceptable result from a data processing audit for each pollutant, as appropriate		
Pollutant	**Acceptance Criteria**	**Data Concentration Level**

Question	Yes	No	Comment
Are procedures documented and implemented for corrective actions based on results of data audits which fall outside the established limits?			If yes, where are such corrective action procedures documented?

5. Corrective Action System

Question	Yes	No	Comment
Does the agency have a comprehensive Corrective Action program in place and operational?			
Have the procedures been documented?			
As a part of the agency QA Plan?			
As a separate Standard Operating Procedure?			
How is responsibility for implementing corrective actions on the basis of audits, calibration problems, zero/span checks, etc assigned? Briefly discuss.			
How does the agency follow up on implemented corrective actions?			

6. Audit Result Acceptance Criteria

Question	Yes	No	Comment
Has the agency established and has it documented criteria to define agency-acceptable audit results?			
Question	**Yes**	**No**	**Comment**
Were these audit criteria based on, or derived from, the guidance found in Vol./. II of the QA Handbook for Air Pollution Measurement System, Section 2.0.12?			If no, please explain. If yes, please explain any changes or assumptions made in the derivation.
What corrective action may be taken if criteria are exceeded?			

As a goal, the 95 percent probability limits for precision (all pollutants) should be less than +/- 15 percent. At 95 percent probability limits, the accuracy for PM10 should be less than +/- 15% and all other pollutants should be less than +/- 20 percent. Using a short narrative and a summary table, compare the reporting organizations performance against these goals over the last year. Explain any deviations.